TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1894

VOL. XXVII.

(Tenth of New Series)

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

SIR JAMES HECTOR, K.C.M.G., M.D., F.R.S.

Director

Issued May, 1895

WELLINGTON

SAMUEL COSTALL, GOVERNMENT PRINTING OFFICE

TRÜBNER & CO., 57 & 59, LUDGATE HILL, LONDON, E.C

BIOLOGICAL LABORATORY LIBRARY

CORRIGENDUM.

Pages 200 and 202. *For* Strolasterias *read* Stolasterias.

CONTENTS.

TRANSACTIONS.

I.—Zoology.

Art.		pages
I.	Synoptical List of Coccidæ reported from Australasia and the Pacific Islands up to December, 1894. By W. M. Maskell, Registrar of the University of New Zealand, Corr. Mem. Roy. Soc. of South Australia	1–35
II.	Further Coccid Notes: with Descriptions of New Species from New Zealand, Australia, Sandwich Islands, and elsewhere, and Remarks upon many Species already reported. By W. M. Maskell ..	36–75
III.	Illustrations of Darwinism; or, The Avifauna of New Zealand considered in Relation to the Fundamental Law of Descent with Modification. By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S., &c.	75–104
IV.	Notes on the Ornithology of New Zealand; with an Exhibition of Rare Specimens. By Sir W. L. Buller	104–126
V.	On a New Species of Fern-bird (*Sphenœacus*) from the Snares Islands; with an Exhibition of Specimens. By Sir W. L. Buller	127–128
VI.	Notes on the Flightless Duck of the Auckland Islands (*Nesonetta aucklandica*). By Sir W. L. Buller	128–129
VII.	Notes on *Phalacrocorax colensoi*, of the Auckland Islands, and on *Phalacrocorax onslowi*, of the Chatham Islands. By Sir W. L. Buller ..	129–132
VIII.	Notes on *Œstrelata neglecta*; with an Exhibition of Specimens. By Sir W. L. Buller	132–134
IX.	Some Curiosities of Bird-life. By Sir W. L. Buller	134–142
X.	On the Wetas, a Group of Orthopterous Insects inhabiting New Zealand; with Descriptions of Two New Species. By Sir W. L. Buller	143–147
XI.	Observations on some peculiar Maori Remains, with Remarks on the Ancient Institution of Tapu. By Sir W. L. Buller	148–154
XII.	Note on the Vegetable Caterpillar (*Cordiceps robertsii*). By Sir W. L. Buller	155–156
XIII.	On the Axial Skeleton in the Dinornithidæ. By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum	157–173

32389

Art.		Pages
XIV.	On the Occurrence of a Pneumatic Foramen in the Femur of a Moa. By Captain F. W. Hutton ..	173–174
XV.	On a New Species of Weta (*Locustidæ*) from Bounty Island. By Captain F. W. Hutton	174–176
XVI.	On *Majaqueus æquinoctialis*, from Antipodes Island. By Captain F. W. Hutton	177
XVII.	Notes on New Zealand Land Planarians: Part I. By Arthur Dendy, D.Sc., Professor of Biology in the Canterbury College, University of New Zealand	177–189
XVIII.	Note on a New Variety of *Peripatus novæ-zealandiæ*, Hutton. By Arthur Dendy	190–191
XIX.	Notes on a New Zealand Land Nemertine. By Arthur Dendy	191–194
XX.	Notes on New Zealand Echinoderms. By H. Farquhar..	194–208
XXI.	Descriptions of Two New Gymnoblastic Hydroids. By H. Farquhar	208–209
XXII.	Notes on some Crustacea from Macquarie Island. By George M. Thomson, F.L.S.	210–214
XXIII.	On the most frequent Pelagic Copepods and Cladoceres of the Hauraki Gulf. By Dr. Augustus Krämer, Physician H.I.M.S. "Bussard"	214–223
XXIV.	Notes on the Larger Species of *Paryphanta* in New Zealand, with some Remarks on the Distribution and Dispersal of Land-shells. By W. T. L. Travers, F.L.S.	224–228
XXV.	Further Contributions towards a Bibliography of the Dinornithidæ, the Great Extinct Birds of New Zealand, usually called Moas: Supplement No. 1. By A. Hamilton	228–231
XXVI.	On the Feathers of a Small Species of Moa (*Megalapteryx*) found in a Cave at the Head of the Waikaia River; with a Notice of a Moa-hunter's Camping-place on the Old Man Range. By A. Hamilton	232–238
XXVII.	Zoological Notes: (1) Arboreal Nests of Bush-rat (*Mus maorium*); (2) *Paryphanta hochstetteri* found at Low Levels at West Wanganui. By R. I. Kingsley	238–239
XXVIII.	Remarks on the Rats of New Zealand. By Taylor White	240–261
XXIX.	On the Bird Moa and its Aliases. By Taylor White	262–273
XXX.	The Kea (*Nestor notabilis*), a Sheep-eating Parrot. By Taylor White	273–280
XXXI.	On the Abundance of *Vanessa itea* in Wellington during Season 1894. By Water P. Cohen ..	281
XXXII.	A Chapter in the History of the Warfare against Insect-pests. By W. M. Maskell	282–284
XXXIII.	On the Anatomy of Flight of Certain Birds. By Sir James Hector, F.R.S.	284–287
XXXIV.	Further Contribution to a Knowledge of the New Zealand Sponges. By H. B. Kirk, M.A. ..	287–292
XXXV.	On a New Shell (*Anomia walteri*). By Sir J. Hector	292–293
XXXVI.	On some New Species of *Tipulæ* (Daddy-long-legs) found in New Zealand. By G. V. Hudson, F.E.S.	293–295

II.—Botany.

Art.		Pages
XXXVII.	The Algæ of New Zealand: their Characteristics and Distribution. By Robert M. Laing, B.Sc. ..	297–318
XXXVIII.	On the Preparation and Preservation of Botanical Specimens. By T. Kirk, F.L.S.	318–327
XXXIX.	On New Forms of *Celmisia*, Cass. By T. Kirk, F.L.S.	327–330
XL.	A Revision of the New Zealand Gentians. By T. Kirk	330–341
XLI.	On the New Zealand Species of *Gunnera*, L. By T. Kirk	341–348
XLII.	Descriptions of New or Remarkable Plants from the Upper Waimakariri. By T. Kirk	349–353
XLIII.	Description of New Grasses from Macquarie Island. By T. Kirk	353–354
XLIV.	A Revision of the New Zealand Species of *Colobanthus*, Bartling. By T. Kirk	354–359
XLV.	Notes and Reminiscences of Early Crossings of the romantically-situated Lake Waikaremoana, County of Hawke's Bay, of its Neighbouring Country, and of its peculiar Botany; performed in the Years 1841 and 1843. By W. Colenso, F.R.S., F.L.S. (Lond.), &c.	359–382
XLVI.	Phænogams: A Description of a few more Newly-discovered Indigenous Plants; being a Further Contribution towards the making known the Botany of New Zealand. By W. Colenso ..	383–399
XLVII.	A Description of Two New Ferns and One New *Lycopodium*, lately detected in our New Zealand Forests. By W. Colenso	399–401
XLVIII.	An Account of the Finding of Two Australian Plants, hitherto unnoticed, here in New Zealand. By W. Colenso	401–402
XXXIX.	On New Zealand Mosses. By T. W. Naylor Beckett, F.L.S.	403–405
L.	Description of New Native Plants. By D. Petrie, M.A., F.L.S.	405–406
LI.	On the Presence of some Noxious Weeds in Nelson District. By R. I. Kingsley	407
LII.	Botanical Notes: Plants new to Nelson District, &c., from West Wanganui. By R. I. Kingsley ..	407–409
LIII.	Notes on New Zealand Mosses: Genus *Grimmia*, By Robert Brown	409–421
LIV.	Notes on New Zealand Mosses: Genus *Orthotrichum*. By Robert Brown	422–446
LV.	On the Growth of Ferns; and on a New Fern now first reported. By H. C. Field	446–450

III.—Geology.

LVI.	On the Hawke's Bay Pleistocene Beds and the Glacial Period. By H. Hill, F.G.S.	451–476
LVII.	On the Occurrence of Moa Footprints in the Bed of the Manawatu River, near Palmerston North. By H. Hill..	476–477
LVIII.	The Nuhaka Hot Springs. By H. Hill	478–479

IV.—Miscellaneous.

		PAGES
Art. LIX.	Magnetization of Iron by High-frequency Discharges. By E. Rutherford, M.A.	481–513
LX.	The Last Glacial Epoch: explained by Major-General Drayson's Discovery of the Second Rotation of the Earth. By Major-General Schaw, C.B., R.E.	513–534
LXI.	On some Peculiar Cases of the Reflection of Light. By Major-General Schaw	535–538
LXII.	The Immortality of the Cosmos; being an Attempt to show that the Theory of the Dissipation of Energy is limited to Finite Portions of Space. By Professor Bickerton	538–545
LXIII.	Synoptic Statement of the Principles and Phenomena of Cosmic Impact: prepared for the Criticism of Scientific Men and Societies. By Professor Bickerton	545–558
LXIV.	On an Oversight in Croll's Mode of lengthening the Age of the Sun's Heat. By Professor Bickerton	558–559
LXV.	Notes on a Visit to Macquarie Island. By A. Hamilton	559–579
LXVI.	Myths of Observation. By Edward Tregear ..	579–593
LXVII.	Ceremonial Language. By Edward Tregear ..	593–597
LXVIII.	The Modern History of a Block of Greenstone. By W. Colenso, F.R.S., &c.	598–606
LXIX.	Notes on Tombs of a Prehistoric Race of Colombia, South America. By R. I. Kingsley	606–609
LXX.	Maori Preserved Heads. By the Rev. Philip Walsh	610–616
LXXI.	Some Account of the Earliest Literature and Maps relating to New Zealand. By Dr. T. M. Hocken, F.L.S.	616–634

I.—Zoology—*continued.*

LXXII.	On a New Species of Ant from New Zealand. By Professor C. Emery, University of Bologna, Italy: communicated by W. W. Smith	635–636

NEW ZEALAND INSTITUTE.

Twenty-sixth Annual Report	639–640
Accounts for 1893–94	640

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

The Humist Doctrine of Causation in its Relation to Modern Agnosticism. By W. W. Carlile, M.A.	646–647
Resolution as to Dr. C. V. Riley	649
On the Milk-supply of Wellington. By C. Hulke	654

PAGES

On a Discovery of Bones of *Dinornis giganteus* on the surface. By Sir J. Hector 655–656
On a Method of Cure in Germ-diseases. By R. J. Barnes .. 657
Note on the Aurora Australis, as observed at Karori, Wellington, on the 20th August, 1894. By G. V. Hudson 657–658
Exhibit of Tuatara (*Sphenodon punctatum*) and Young. By Sir W. L. Buller 659
Appendix to Paper on the Glacial Epoch. By Major-General Schaw 660–661
On a Peculiar Appearance in a Cloud during the Daylight. By A. J. Lichfield 663
On Baryte: a Rare Form. By Sir J. Hector 664
Pélé's Hair (Volcanic Glass-fibre). By Sir J. Hector 664
On the Occurrence of a Mineral Belt in the Heart of the great Schist-formation of Otago. By Sir J. Hector 664–665
On the so-called Vegetable Caterpillar, and other Fungi that attack Insects. By W. M. Maskell 665–666
On Oyster-culture in New Zealand. By Sir J. Hector .. 670
Remarks on *Paryphanta hochstetteri*. By Sir W. L. Buller .. 670–671
Abstract of Annual Report 671
Election of Officers for 1895 671
On the Utilization of Mineral Springs in New Zealand for the Production of Ornamental Objects in Stone. By C. Smith .. 671
Notes from the Chatham Islands. By Major Gascoyne: communicated by Sir W. L. Buller 671–672
On a New Fern. By H. C. Field 672
On some Living Colonial Rarities. By H. C. Field 672
On a Process for coating Non-conducting Substances with Metal. By H. N. McLeod 672

AUCKLAND INSTITUTE.

The History of Money: Anniversary Address by J. H. Upton, President 673
The Economic Effects of Various Land-tenures. By E. Withy 673
Description of the Carved Maori House at Maketu. By T. F. Cheeseman 674
The Geology, Resources, and Prospects of the Thames Goldfields. By James Park, F.G.S. 674
A Greek Madonna. By Professor Arnold Tubbs 675
The Treatment of Lunatics, historically considered. By F. G. Ewington 675–676
Comparative Religion. By the Rev. J. Bates 676
Poetry considered as an Interpretation of Life. By Professor Egerton 676
A Yorkshire Blood-feud. By F. D. Fenton 676
Darwin. By Professor A. P. Thomas 677
Shooting-stars and Meteors. By Professor H. W. Segar .. 677
A Poet's Socialism. By E. A. Mackechnie 677
Explosives. By Professor F. D. Brown 677
Abstract of Annual Report 677–679
Election of Officers for 1895 679

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

On a Concrete Conception of Angles and Parallels. By J. R. Wilkinson, M.A. 680
Modern Views of Protoplasm. By R. M. Laing, M.A. .. 680
On the Conditions of Equilibrium of Free Gaseous Cosmical Bodies under Varying Conditions of Volume, Composition, Temperature, and Mass. By Professor Bickerton .. 681

PAGE
Curves of Gravitation. By Professor Bickerton 681
On Disposing Affinity and the Constitution of difficultly-decomposable Cyanides. By Professor Bickerton 681
Note on the Observation of Microseismic Waves. By G. Hogben, M.A. 681
Note on Land Planarians of New Zealand. By A. Dendy, D.Sc. 682
On Six Pieces of Apparatus to determine experimentally the various Lines of Force upon which Scientific Apparatus is founded. By Professor Bickerton 682
On Molecular Attraction. By Professor Bickerton 682
On the Specific Heat of the Elements, deduced from the Specific Heat of Compound Gases at Constant Volume. By Professor Bickerton 682
On Chlorine as a Cure for Consumption. By Professor Bickerton 682
On Hail. By Professor Bickerton 682
On a Simple Classification of Organic Compounds. By Professor Bickerton 682
On a Simple Method of representing the Graphic Constitution of Organic Bodies. By Professor Bickerton 682
Abstract of Annual Report 682
Election of Officers for 1895 682

OTAGO INSTITUTE.

The Appreciation of Gold. By Professor F. B. de M. Gibbons .. 683
On the Characteristics and Life-history of the principal Parasitic Worms infesting Man. By Professor Parker 683
On the Structure and Systematic Position of *Anaspis*. By G. M. Thomson 683
On the Financial Depression, its Cause and Remedy. By E. Melland 683
Remarks on Ethnological Specimens from New Guinea. By Professor Parker 683
On some Female Characters in the Plays of Sophocles. By the Rev. Dr. Belcher 683
On Recent Discoveries at Megalopolis, in Arcadia. By the Rev. Dr. Belcher.. 684
Remarks on the Leg-bone of a *Megalapteryx*. By Professor Parker 684
Remarks on Additions to the Museum. By Professor Parker .. 684
Remarks on a Collection of New Zealand Fishes. By Professor Parker 684
Abstract of Annual Report 685
Election of Officers for 1895 685

WESTLAND INSTITUTE.

Abstract of Annual Report 686
Election of Officers for 1895 686

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

On Spectacles. By Dr. F. W. Innes 687
Some Curious and Little-known Information and Memoranda relating to Letters and Mails in the Olden Time. By W. Colenso, F.R.S., F.L.S. (Lond), &c. 687
On Corals and Coral Islands. By Dr. Moore 688
Presentation to the Rev. W. Colenso, F.R.S. 688–689
Abstract of Annual Report 690
Election of Officers for 1895 690

NELSON PHILOSOPHICAL SOCIETY.

PAGE

Description of a Journey to Mount Cook. By Dr. J. Hudson .. 691
Additions to Museum exhibited 691
Rat's Nest found in a Hedge exhibited 692
Appendix to Notes on Tregear's Maori-Polynesian Dictionary. By A. S. Atkinson 692
On the Bacilli of Tetanus. By Dr. Hudson 692
Exhibit of Lizard and its Young (*Naultinus elegans*) 692
Resolution as to Mr. Atkinson's Notes on Tregear's Maori-Polynesian Dictionary 692
Abstract of Annual Report 693
Election of Officers for 1895 693
On the Importance of the Study of Natural History. By the Bishop of Nelson 693

APPENDIX.

Meteorological Statistics for 1894 697
Notes on the Weather in 1894 698
Earthquakes reported in New Zealand during 1894 699
Honorary Members of the New Zealand Institute 700
Ordinary Members of the New Zealand Institute 701–709
List of Institutions and Persons to whom this Volume is presented 710–714
Index 715–719

Corrigendum .. .. iv.
Contents .. .. v.–xi.
List of Plates .. .. xiii.–xiv.
Board of Governors of the New Zealand Institute .. .. xv.
Abstracts of Rules and Statutes of the New Zealand Institute .. xv.–xvii.
List of Incorporated Societies .. .. xviii.
Officers of Incorporated Societies, and Extracts from the Rules xviii.–xxi.

LIST OF PLATES.

NOTE.—These are placed together at the end of the volume.

	Author.	
I.	MASKELL.—	Coccidæ
II.	"	"
III.	"	"
IV.	"	"
V.	"	"
VI.	"	"
VII.	"	"
VIII.	BULLER.—	Vegetable Caterpillar
IX.	HUTTON.—	*Pachyornis pygmæus*
X.	FARQUHAR.—	Echinoderms
XI.	"	"
XII.	"	"
XIII.	"	"
XIV.	THOMSON.—	*Guernea antarctica*
XV.	KRÄMER.—	Copepods
XVI.	"	"
XVII.	"	"
XVIII.	"	"
XIX.	"	"
XX.	"	"
XXI.	"	Cladoceres
XXII.	"	"
XXIII.	"	"
XXIV.	H. B. KIRK.—	Sponges
XXV.	"	"
XXVI.	"	"
XXVIA.	T. KIRK.—	Botanical Press
XXVII.	"	Gentians
XXVIIA.	"	"
XXVIIB.	"	"
XXVIIC.	"	"
XXVIID.	"	Colobanthus buchanani
XXVIIE.	"	" brevisepalus
XXVIII.	BECKETT.—	*Blindia tenuifolia*
XXIX.	BROWN.—	Mosses: Genus *Grimmia*
XXX.	"	" "
XXXI.	"	" "
XXXII.	"	" "
XXXIII.	"	" "
XXXIV.	"	" "
XXXV.	"	" Genus *Orthotrichum*
XXXVI.	"	" "
XXXVII.	"	" "
XXXVIII.	"	" "
XXXIX.	"	" "
XL.	"	" "
XLI.	"	" "
XLII.	"	" "

	Author.
XLIII.	Hill.—Geology of Hawke's Bay
XLIV.	" " "
XLV.	Schaw.—Theory of Glacial Epoch
XLVI.	" Theory of Reflections
XLVII.	Hill.—Moa Footprints
XLVIII.	Rutherford.—Magnetization of Iron
XLIX.	" "
L.	Hamilton.—Macquarie Island
LI.	Kingsley.—Prehistoric Tombs

MARINE BIOLOGICAL LABORATORY
WOODS HOLE
LIBRARY

NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

Board of Governors.

(EX OFFICIO.)

His Excellency the Governor.
The Hon. the Colonial Secretary.

(NOMINATED.)

The Hon. W. B. D. Mantell, F.G.S.; W. T. L. Travers, F.L.S.; Sir James Hector, K.C.M.G., M.D., F.R.S.; W. M. Maskell; Thomas Mason; E. Tregear, F.R.G.S.

(ELECTED.)

1894.—James McKerrow, F.R.A.S.; S. Percy Smith, F.R.G.S.; Major-General Schaw, C.B., R.E.

Manager: Sir James Hector.

Honorary Treasurer: W. T. L. Travers, F.L.S.

Secretary: R. B. Gore.

ABSTRACTS OF RULES AND STATUTES.

Gazetted in the "New Zealand Gazette," 9th March, 1868.

Section I.

Incorporation of Societies.

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for

which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and library of the New Zealand Institute.

4. Any society incorporated as aforesaid, which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and may then be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:—

Regulations regarding Publications.

(*a.*) The publications of the Institute shall consist of a current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions, comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), to be intituled "Transactions of the New Zealand Institute."

(*b.*) The Institute shall have power to reject any papers read before any of the incorporated societies.

(*c.*) Papers so rejected will be returned to the society in which they were read.

(*d.*) A proportional contribution may be required from each society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e.*) Each incorporated society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f.*) Extra copies will be issued to any of the members of incorporated societies at the cost-price of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the society.

Section II.

For the Management of the Property of the Institute.

9. All donations by societies, public departments, or private individuals to the Museum of the Institute shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal, to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to natural science may be deposited in the library of the Institute, subject to the following conditions :—

(*a.*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b.*) Any funds especially expended on binding and preserving such deposited books at the request of the depositor shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c.*) No books deposited in the library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and library, subject to by-laws to be framed by the Board.

Section III.

The laboratory shall for the time being be and remain under the exclusive management of the Manager of the Institute.

Section IV.

(Of Date 23rd September, 1870.)

Honorary Members.

Whereas the rules of the societies incorporated under the New Zealand Institute Act provide for the election of honorary members of such societies, but inasmuch as such honorary members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of honorary members of the New Zealand Institute, it is hereby declared,—

1. Each incorporated society may, in the month of November next, nominate for election, as honorary members of the New Zealand Institute, three persons, and in the month of November in each succeeding year one person, not residing in the colony.
2. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.
3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society -	10th June, 1868.
Auckland Institute - - - - -	10th June, 1868.
Philosophical Institute of Canterbury	22nd Oct., 1868.
Otago Institute - - - - -	18th Oct., 1869.
Westland Institute - - - -	21st Dec., 1874.
Hawke's Bay Philosophical Institute -	31st Mar., 1875.
Southland Institute - - - -	21st July, 1880.
Nelson Philosophical Society - -	20th Dec., 1883.

OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1895.—*President*—Thomas Kirk, F.L.S.; *Vice-presidents*—W. T. L. Travers, F.L.S., R. C. Harding; *Council*—W. M. Maskell, G. V. Hudson, F.E.S., Sir J. Hector, F.R.S., Edward Tregear, F.R.G.S., Major-General Schaw, C.B., R.E., Sir W. L. Buller, F.R.S., H. Farquhar; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1895.—*President*—Professor A. P. Thomas, F.L.S.; *Vice-president*—J. H. Upton; *Council*—Rev. J. Bates, W. Berry, Professor F. D. Brown, F.C.S., E. A. Mackechnie, G. Mueller, T. Peacock, J. A. Pond,

T. H. Smith, J. Stewart, C.E., Professor H. A. Tubbs, E. Withy; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

Extracts from the Rules of the Auckland Institute.

1. Any person desiring to become a member of the Institute shall be proposed in writing by two members, and shall be balloted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance-fee, in addition to the annual subscription of one guinea, the annual subscription being payable in advance on the first day of April for the then current year.

5. Members may at any time become life-members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual general meeting of the society on the third Monday of February in each year. Ordinary business meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1895.—*President*—Dr. A. Dendy; *Vice-presidents*—Dr. W. Thomas, Mr. R. M. Laing; *Hon. Secretary*—Mr. R. Speight; *Hon. Treasurer*—Mr. J. T. Meeson; *Council*—Dr. W. H. Symes, Professor Bickerton, Dr. W. P. Evans, Messrs. H. R. Webb, S. Hurst Seager, S. Page.

Extracts from the Rules of the Philosophical Institute of Canterbury.

8. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the 1st November in each year.

The Institute may also admit associates, who shall contribute five shillings annually to the funds of the Institute, and shall have all the privileges of members, except that they shall not have the power to vote, or be entitled to the annual volume of the Transactions.

9. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

15. The ordinary meetings of the Institute shall be held on the first Wednesday in each month during the months of May to October, both inclusive.

OTAGO INSTITUTE.

Office-bearers for 1895.—*President*—Charles Chilton, D.Sc.; *Vice-presidents*—Edward Melland, Augustus Hamilton; *Hon. Secretary*—Professor T. Jeffery Parker, D.Sc., F.R.S.; *Hon. Treasurer*—Professor F. B. de M. Gibbons, M.A.; *other Members of Council*—T. M. Hocken, M.R.C.S., F.L.S., Professor John H. Scott, M.D., F.R.S.E., the Rev. Henry Belcher, M.A., LL.D., Frederick R. Chapman, C. W. Adams, C.E., J. S. Tennant, B.A., B.Sc., G. M. Thomson, F.L.S.; *Auditor*—Daniel Brent, M.A.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the society may be elected by ballot, on being proposed in writing at any meeting of the Council or society by two members, and on payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings in lieu of future annual subscriptions.

8. An annual general meeting of the members of the society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

WESTLAND INSTITUTE.

Office-bearers for 1895. — *President* — A. H. King; *Vice-president* — D. Macfarlane; *Hon. Treasurer* — T. O. W. Croft; *Trustees*—J. Chesney, A. Mahan, D. Barron, H. L. Michel, J. Churches, A. E. Cresswell, W. L. Fowler, T. H. Gill, A. J. Morton, R. W. Wade, Dr. Macandrew, and Dr. Kendall.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist (1) of life-members—*i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards, or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting; (2) of members who pay two pounds two shillings each year; (3) of members paying smaller sums, not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1895. — *President* — J. W. Carlile, M.A.; *Vice-president* — H. H. Pinckney, B.A.; *Council* — T. Humphries,, J. W. Craig, H. Hill, B.A., F.G.S., J. S. Large, G. Pitcaithley, B.A., Dr. A. Milne-Thompson; *Hon. Secretary* — W. Dinwiddie; *Hon. Treasurer* — G. White; *Auditor*—J. Crerar.

Extracts from the Rules of the Hawke's Bay Philosophical Institute.

3. The annual subscription for each member shall be one guinea, payable in advance on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

SOUTHLAND INSTITUTE.

OFFICE-BEARERS. — *Trustees* — Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

NELSON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1895. — *President* — The Bishop of Nelson; *Vice-presidents*—Mr. A. S. Atkinson, Dr. J. W. Mackie; *Hon. Secretary*—Mr. R. I. Kingsley; *Hon. Treasurer*—Dr. J. Hudson; *Council* — Dr. Boor, Messrs. E. Lukins, F. Worley, J. Holloway, and J. G. Bartell; *Hon. Curator of Museum*—Mr. R. I. Kingsley; *Assistant Curator*—Mr. E. Lukins.

Extracts from the Rules of the Nelson Philosophical Society.

4. That members shall be elected by ballot.

6. That the annual subscription shall be one guinea.

7. That the sum of ten guineas may be paid in composition of the annual subscription.

16. That the meetings be held on the second Monday in every month.

23. The papers read before the Society shall be immediately delivered to the Secretary.

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1894.

I.—ZOOLOGY.

ART. I.—*Synoptical List of* Coccidæ *reported from Australasia and the Pacific Islands up to December, 1894.*

By W. M. MASKELL, Registrar of the University of New Zealand, Corr. Mem. Roy. Soc. of South Australia.

[*Read before the Wellington Philosophical Society, 17th October, 1894.*]

Sub-family DIASPIDINÆ.

Genus **Aspidiotus**, Bouché.

This genus is cosmopolitan.

ASPIDIOTUS ACACIÆ, Morgan.—Morgan, Ent. Mo. Mag., Aug., 1889, p. 353; Maskell, N.Z. Inst. Trans., 1892, p. 205.

Hab. In Tasmania, on *Acacia pycnantha;* in New South Wales, on *Eucalyptus* sp. (Whitton).

ASPIDIOTUS ACACIÆ, Morgan, var. *propinqua*, Maskell.—Maskell, N.Z. Trans., 1892, p. 205.

Hab. In New South Wales, on *Acacia* sp. (Mount Victoria); on *Hakea saligna* (Sydney).

ASPIDIOTUS ATHEROSPERMÆ, Maskell.—Maskell, N.Z. Trans., 1878, p. 198; Scale-Insects of N.Z., 1887, p. 40.

Hab. In New Zealand, on *Atherosperma novæ-zealandiæ* (Wellington; Hawke's Bay).

Aspidiotus aurantii, Maskell. *Aspidiotus coccineus*, Gennadius (Risso, Hist. Nat. des Oranges). *Aspidiotus citri*, Comstock, Canadian Entomologist, vol. xiii., p. 8.—Maskell, N.Z. Trans. 1878, p. 199; ib., 1881, p. 217; ib., 1883, p. 120; ib., 1891, p. 12; ib., 1892, p. 206; ib., 1894, p. 40; Scale-Insects of N.Z., 1887, p. 40. Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 293; 2nd Cornell University Ent. Rep., 1883, p. 59. Riley and Howard, "Insect Life," passim. Royal Gardens, Kew, Bulletin, Sept., 1891, p. 221.

Hab. In Australia, New Zealand, Fiji, Sandwich Islands, Samoa, Tonga, New Caledonia, on *Citrus*. Occurs on the same trees in many other countries: in California and in Jamaica on *Eucalyptus*, *Lignum-vitæ*, &c.

Aspidiotus bossieæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 10.

Hab. In Australia, on *Bossiea procumbens* (Victoria).

Aspidiotus budleiæ, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1868, p. 115. Maskell, N.Z. Trans., 1878, p. 198; Scale-Insects of N.Z., 1887, p. 40.

Hab. In New Zealand, on *Acacia* sp. (Nelson).

Aspidiotus camelliæ, Signoret. *Aspidiotus rapax*, Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 307.—Signoret, Ann. de la Soc. Ent. de France, 1868, p. 117. Maskell, N.Z. Trans., 1878, p. 200; ib., 1884, p. 21; ib., 1890, p. 3; ib., 1894, p. 39; Scale-Insects of N.Z., 1887, p. 41. Morgan, Ent. Mo. Mag., Aug., 1889, p. 351.

Hab. In New Zealand, on *Camellia japonica*, *Euonymus japonicus*, *Salix babylonica* (Christchurch; Wellington); in Europe, on *Camellia;* in North America, on *Euonymus*, *Olea*, and other plants.

Aspidiotus carpodeti, Maskell.—Maskell, N.Z. Trans., 1884, p. 21; Scale-Insects of N.Z., 1887, p. 41.

Hab. In New Zealand, on *Carpodetus serratus*, *Vitex littoralis* (Wellington).

Aspidiotus casuarinæ, Maskell.—Maskell, N.Z. Trans., 1893, p. 66.

Hab. In Australia, on *Casuarina equisetifolia* (New South Wales).

Aspidiotus ceratus, Maskell.—Maskell, N.Z. Trans., 1894, p. 39.

Hab. In Australia, on *Acacia stenophylla* (South Australia).

ASPIDIOTUS CLADII, Maskell.—Maskell, N.Z. Trans., 1890, p. 3; ib., 1892, p. 205; ib., 1893, p. 67; ib., 1894, p. .

Hab. In Australia, on *Cladium* sp. (Victoria); on *Lepidosperma* sp. (South Australia); on *Xerotes* sp. (New South Wales).

ASPIDIOTUS COROKIÆ, Maskell.—Maskell, N.Z. Trans., 1890, p. 2.

Hab. In New Zealand, on *Corokia cotoneaster* (Reefton).

ASPIDIOTUS CYDONIÆ, Comstock.—Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 295. Maskell, N.Z. Trans., 1891, p. 13.

Hab. In Samoa, on *Citrus;* in North America, on *Cydonia vulgaris* (Florida).

ASPIDIOTUS DYSOXYLI, Maskell.—Maskell, N.Z. Trans., 1878, p. 198; Scale-Insects of N.Z., 1887, p. 43.

Hab. In New Zealand, on *Dysoxylon spectabile* (Wellington).

ASPIDIOTUS EPIDENDRI, Bouché. *Chermes epidendri*, Boisduval.—Bouché, Ent. Zeit. Stett., 1844, p. 293. Boisduval, Ent. Hort., 1867, p. 339. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 121. Maskell, N.Z. Trans., 1878, p. 197; Scale-Insects of N.Z., 1887, p. 44.

Hab. In New Zealand, on *Acacia* sp. (Christchurch); in Europe, on hothouse orchids.

ASPIDIOTUS EUCALYPTI, Maskell.—Maskell, Trans. Roy. Soc. South Australia, vol. xi., 1887–88, p. 102; N.Z. Trans., 1891, p. 11; ib., 1892, p. 206.

Hab. In Australia, on *Eucalyptus*, var. sp. (South Australia); on *Casuarina* sp. (New South Wales).

ASPIDIOTUS EXTENSUS, Maskell.—Maskell, N.Z. Trans., 1894, p. 41.

Hab. In Australia, on *Eucalyptus capitellata* (New South Wales; Victoria).

ASPIDIOTUS FICUS, Comstock.—Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 296. Maskell, N.Z. Trans., 1894, p. 39.

Hab. In Australia, on various plants, probably *Citrus*, in Botanical Gardens, and elsewhere (New South Wales; Queensland).

ASPIDIOTUS FODIENS, Maskell.—Maskell, N.Z. Trans., 1891, p. 10.

Hab. In Australia, on *Acacia* sp. (Victoria).

ASPIDIOTUS KENNEDYÆ, Boisduval.—Boisduval, Ent. Hort.,

1867, p. 326. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 124.

Hab. In "New Holland," on *Kennedya* sp.

Aspidiotus longispina, Morgan.—Morgan, Ent. Mo. Mag., August, 1889, p. 352. Maskell, N.Z. Trans., 1894, p. 38.

Hab. In Sandwich Islands, on *Citrus* and *Mangifera*; in Demerara, on *Cupania sapida*.

Aspidiotus nerii, Bouché. *Aspidiotus bouchei*, Targioni-Tozzetti.—Bouché, Schädl. Gart. Insek., 1883, p. 52. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 126. Targioni, Studie sulle Coccineglie, 1867. Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 301. Maskell, N.Z. Trans., 1881, p. 217; Scale-Insects of N.Z., 1887, p. 44.

Hab. In New Zealand, on *Coprosma lucida* and *Corynocarpus lævigatus* (Wellington); in Australia, on *Oleander*, *Citrus*, *Acacia*, &c. (South Australia; New South Wales; Victoria; Queensland); in Sandwich Islands, on apple and pear; in North America, on *Citrus*, *Oleander*, &c.; in Europe, on many diverse plants.

Probably cosmopolitan and omnivorous.

Aspidiotus phormii, Brème.—Signoret, Ann. de la Soc. Ent. de France, 1868, p. 130.

Hab. In Europe, on *Phormium tenax* (New Zealand flax).

Aspidiotus rossi, Maskell (Crawford).—Maskell, N.Z. Trans., 1890, p. 3; ib., 1891, p. 11; ib., 1892, p. 207.

Hab. In Australia, on *Oleander*, *Eucalyptus*, *Ricinocarpus*, *Xanthorrhea*, and many other plants (South Australia; Victoria; New South Wales; Queensland).

Aspidiotus sophoræ, Maskell.—Maskell, N.Z. Trans., 1883, p. 121; Scale-Insects of N.Z., 1887, p. 45.

Hab. In New Zealand, on *Sophora tetraptera* (Christchurch).

Aspidiotus subrubescens, Maskell.—Maskell, N.Z. Trans., 1891, p. 9; ib., 1892, p. 207.

Hab. In Australia, on *Eucalyptus*, var. sp. (Victoria); on *Banksia* sp. (New South Wales).

Aspidiotus unilobis, Maskell.—Maskell, N.Z. Trans., 1894, p. 40.

Hab. In Australia, on *Acacia* sp. (tea-tree) (New South Wales).

Aspidiotus vitiensis, Maskell.—Maskell, N.Z. Trans., 1894, p. 40.

Hab. In Fiji, on various forest-trees.

Genus **Aonidia**, Targioni-Tozzetti.

This genus has hitherto been reported only from Europe and Australia.

AONIDIA FUSCA, Maskell.—Maskell, N.Z. Trans., 1894, p. 43.

Hab. In Australia, on peach (New South Wales).

Genus **Diaspis**, Costa.

This genus appears to be nearly, if not quite, cosmopolitan, but probably prefers tropical or, at least, warm countries.

DIASPIS AMYGDALI, Tryon.—Tryon, "Report on Insect- and Fungus-pests," 1889, p. 89. Maskell, N.Z. Trans., 1894, p. 44.

Hab. In Australia, on peach (*Persica vulgaris*) (New South Wales; Queensland).

DIASPIS BOISDUVALII, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1868, p. 432. Maskell, N.Z. Trans., 1878, p. 200; ib., 1884, p. 23; ib., 1894, p. 44; Scale-Insects of N.Z., 1887, p. 46.

Hab. In New Zealand, on various hothouse plants (Christchurch; Wellington); on *Acacia* sp. (Wellington); in Australia, on hothouse orchids (South Australia); in Europe, on hothouse orchids; in Sandwich Islands, on orchids.

DIASPIS FIMBRIATA, Maskell.—Maskell, N.Z. Trans., 1892, p. 208.

Hab. In Australia, on *Eugenia smithii* (New South Wales).

DIASPIS PINNULIFERA, Maskell.—Maskell, N.Z. Trans. 1890, p. 4; ib., 1892, p. 208; ib., 1894, p. 44.

Hab. In Fiji, on (?); in Demerara, on *Croton* sp.

DIASPIS ROSÆ, Sandberg. — Sandberg, Abhand. priv. Boh., 1784, p. 317. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 441. Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 312. Maskell, N.Z. Trans., 1878, p. 201; Scale-Insects of N.Z., 1887, p. 47.

Hab. In New Zealand, on rose (passim); in Sandwich Islands, on rose; in Australia, on rose (passim); in Europe, North America, China, &c., on rose.

DIASPIS SANTALI, Maskell. — Maskell, N.Z. Trans., 1883, p. 122; Scale-Insects of N.Z., 1887, p. 47.

Hab. In New Zealand, on *Santalum cunninghamii* (Hawke's Bay).

Genus **Parlatoria**, Targioni-Tozzetti.

This genus appears to exist (in the open air) only in tropical or warm countries.

Parlatoria myrtûs, Maskell.—Maskell, N.Z. Trans., 1890, p. 12.

Hab. In Australia, on *Myrtus communis* (Victoria).

Parlatoria pittospori, Maskell.—Maskell, N.Z. Trans., 1890, p. 11.

Hab. In Australia, on *Pittosporum undulatum* (Victoria).

Parlatoria proteus, Curtis. *Aspidiotus proteus*, Curtis. *Parlatoria orbicularis*, Targioni-Tozzetti.—Curtis, Gard. Chron., 1843, p. 674. Targioni, Catal., 1868, p. 42. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 451. Comstock, 2nd Corn. Univ. Ent. Rep., 1883, p. 114. Maskell, N.Z. Trans., 1892, p. 213.

Hab. In Australia, on apple (Queensland).

Genus **Mytilaspis**, Targioni-Tozzetti.

This genus is probably cosmopolitan.

Mytilaspis casuarinæ, Maskell.—Maskell, N.Z. Trans., 1892, p. 209.

Hab. In Australia, on *Casuarina* sp.

Mytilaspis citricola, Packard.—Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 321. Maskell, N.Z. Trans., 1889, p. 135; ib., 1894, p. 48.

Hab. In New Zealand, on *Citrus* (Reefton); in Fiji, on *Citrus;* in Australia, on *Citrus* (New South Wales; Queensland); in North America, on *Citrus* (Florida); in South Australia, on *Croton* in stoves; in Victoria, on *Banksia integrifolia.*

Mytilaspis convexa, Maskell.—Maskell, N.Z. Trans., 1893, p. 70.

Hab. In Australia, on *Acacia* sp. (New South Wales).

Mytilaspis cordylinidis, Maskell.—Maskell, N.Z. Trans., 1878, p. 195; Scale-Insects of N.Z., 1887, p. 48.

Hab. In New Zealand, on *Cordyline australis* (passim).

Mytilaspis drimydis, Maskell.—Maskell, N.Z. Trans., 1878, p. 196; Scale-Insects of N.Z., 1887, p. 49.

Hab. In New Zealand, on *Drimys colorata* (Dunedin).

Mytilaspis epiphytidis, Maskell.—Maskell, N.Z. Trans., 1884, p. 21; Scale-Insects of N.Z., 1887, p. 49.

Hab. In New Zealand, on *Astelia cunninghamii* (Wellington).

MYTILASPIS FLAVA, Targioni-Tozzetti, var. *hawaiiensis*, Maskell. — Maskell, N.Z. Trans., 1894, p. 47. Targioni-Tozzetti, Catal., 1868, p. 44. Comstock, 2nd Corn. Univ. Rep., 1883, p. 123.
Hab. In Sandwich Islands, on "bark of shade trees."

MYTILASPIS FORMOSA, Maskell.—Maskell, N.Z. Trans., 1893, p. 68.
Hab. In Australia, on *Eucalyptus orbifolia* (Western Australia); on *Eucalyptus corynocalyx* (South Australia).

MYTILASPIS GLOVERII, Packard.—Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 323. Maskell, N.Z. Trans., 1890, p. 8.
Hab. In Australia, on *Citrus* (Victoria).

MYTILASPIS GRANDILOBIS, Maskell.—Maskell, N.Z. Trans., 1893, p. 70.
Hab. In Australia, on *Banksia* sp. (Victoria).

MYTILASPIS GRISEA, Maskell.—Maskell, N.Z. Trans., 1889, p. 133.
Hab. In Australia, on *Eucalyptus*, var. sp., and on *Acacia*, var. sp. (New South Wales).

MYTILASPIS INTERMEDIA, Maskell.—Maskell, N.Z. Trans., 1890, p. 7.
Hab. In New Zealand, on *Leptospermum scoparium* (Reefton).

MYTILASPIS LACTEA, Maskell.—Maskell, N.Z. Trans., 1894, p. 48.
Hab. In New Zealand, on *Fuchsia excorticata* (Wellington; Woodville).

MYTILASPIS LEPTOSPERMI, Maskell.—Maskell, N.Z. Trans., 1881, p. 215; Scale-Insects of N.Z., 1887, p. 50.
Hab. In New Zealand, on *Leptospermum scoparium* (passim).

MYTILASPIS METROSIDERI, Maskell.—Maskell, N.Z. Trans., 1879, p. 293; Scale-Insects of N.Z., 1887, p. 50.
Hab. In New Zealand, on *Metrosideros robusta* (Wellington).

MYTILASPIS NIVEA, Maskell.—Maskell, N.Z. Trans., 1894, p. 46.
Hab. In Australia, on *Melaleuca nodosa* (New South Wales).

MYTILASPIS PALLENS, Maskell.—Maskell, N.Z. Trans., 1889, p. 134.
Hab. In Australia, on *Xanthorrhea* sp. (New South Wales).

MYTILASPIS PALLIDA, Green, var. (?).—Maskell, N.Z. Trans., 1894, p. 46.
Hab. In Sandwich Islands, on *Podocarpus* sp.

Mytilaspis phymatodidis, Maskell.—Maskell, N.Z. Trans., 1879, p. 292; Scale-Insects of N.Z., 1887, p. 51.

Hab. In New Zealand, on *Phymatodes billardieri* (Auckland; Wellington).

Mytilaspis pomorum, Bouché. *Aspidiotus pomorum*, Bouché, 1851. *Aspidiotus conchiformis*, auctorum. *Aspidiotus pyrus-malus*, Kennicott, 1854. *Aspidiotus juglandis*, Fitch, 1856. *Aspidiotus falciformis*, Bärensprung, 1849. *Mytilaspis pomicorticis*, Riley, 1865. *Mytilaspis pomorum*, Signoret, 1868.—Bouché, Ent. Zeit. Stett., 1851, xii. Kennicott, Acad. Sci. Clevel., 1854. Fitch, Ann. Rep. N.Y. State Ag. Soc., 1856. Bärensprung, Journ. d'Alton et Burm., 1849. Riley, Fifth Rep. Missouri State Ent., p. 95. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 98. Maskell, N.Z. Trans., 1878, p. 192; Scale-Insects of N.Z., 1887, p. 51.

Hab. In New Zealand, on apple, pear, hawthorn, &c. (passim); in Australia, on apple (Victoria); in Sandwich Islands, on apple; in Europe and North America, on apple.

Mytilaspis pyriformis, Maskell.—Maskell, N.Z. Trans., 1878, p. 194; ib., 1881, p. 215; ib., 1884, p. 22; ib., 1890, p. 4; Scale-Insects of N.Z., 1887, p. 53.

Hab. In New Zealand, on *Coprosma* (Christchurch); on *Dysoxylon spectabile*, *Atherosperma novæ-zealandiæ*, *Rhipogonum* sp., *Pinus* sp. (Wellington).

Mytilaspis spinifera, Maskell.—Maskell, N.Z. Trans., 1893, p. 69.

Hab. In Australia, on *Acacia pendula* (New South Wales).

Mytilaspis striata, Maskell.—Maskell, N.Z. Trans., 1894, p. 47.

Hab. In Australia, on *Casuarina* sp. (New South Wales).

Genus **Leucaspis**, Targioni-Tozzetti.

This genus has hitherto been reported only from Europe and Australia.

Leucaspis cordylinidis, Maskell.—Maskell, N.Z. Trans., 1892, p. 209.

Hab. In Australia, on *Cordyline* sp. (New South Wales).

Genus **Poliaspis**, Maskell.

This genus has hitherto been reported only from Australia, New Zealand, and North America.

Poliaspis exocarpi, Maskell.—Maskell, N.Z. Trans., 1891, p. 17; ib., 1893, p. 72; ib., 1894, p. 52.

Hab. In Australia, on *Exocarpus cupressiformis* (Victoria);

on *Santalum* sp. (North Australia); on *Oxylobium trilobatum* (New South Wales).

POLIASPIS MEDIA, Maskell.—Maskell, N.Z. Trans., 1879, p. 293; ib., 1890, p. 9; Scale-Insects of N.Z., 1887, p. 57.

Hab. In New Zealand, on *Veronica* sp., *Leucopogon fraseri, Cyathodes acerosa,* various ferns (Wellington; Nelson; Canterbury).

Genus **Chionaspis**, Signoret.

This genus appears to be cosmopolitan.

CHIONASPIS ASSIMILIS, Maskell.—Maskell, Trans. Roy. Soc. South Australia, 1887–88, p. 102.

Hab. In Australia, on *Eucalyptus*, var. sp. (South Australia).

CHIONASPIS (?) BICLAVIS, Comstock, var. *detecta*, Maskell.—N.Z. Trans., 1894, p. 49. Comstock, 2nd Corn. Univ. Ent. Rep., 1883, p. 98.

Hab. In Sandwich Islands, on bark of (?).

CHIONASPIS BRASILIENSIS, Signoret.—Maskell, N.Z. Trans., 1892, p. 210; ib., 1893, p. 68. Signoret, Ann. de la Soc. Ent. de France, 1868, p. 444.

Hab. In Australia, on orchid (New South Wales); in South America, on (?); in Ceylon, on ferns.

CHIONASPIS CITRI, Comstock.—Maskell, N.Z. Trans., 1884, p. 23; ib., 1892, p. 211; Scale-Insects of N.Z., 1887, p. 54. Comstock, 2nd Corn. Univ. Ent. Rep., 1883, p. 100.

Hab. In Tonga (South Pacific), on *Citrus;* in New Zealand, on *Citrus;* in Australia, on *Citrus;* in North America, on *Citrus.*

CHIONASPIS DUBIA, Maskell.—Maskell, N.Z. Trans., 1881, p. 216; Scale-Insects of N.Z., 1887, p. 54.

Hab. In New Zealand, on *Coprosma, Rubus, Asplenium* (Canterbury; Auckland).

CHIONASPIS DUBIA, Maskell, *forma minor*.—Maskell, N.Z. Trans., 1890, p. 8.

Hab. In New Zealand, on *Leptospermum scoparium, Cyathodes acerosa, Asplenium* sp. (Wellington; Reefton).

CHIONASPIS DYSOXYLI, Maskell.—Maskell, N.Z. Trans., 1884, p. 22; ib., 1889, p. 135; ib., 1890, p. 8; Scale-Insects of N.Z., 1887, p. 55.

Hab. In New Zealand, on *Dysoxylon spectabile, Melicytus ramiflorus, Hoheria angustifolia* (Wellington; Hawke's Bay; Auckland; Canterbury).

Chionaspis eugeniæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 14.

Hab. In Australia, on *Eugenia elliptica*, *Viburnum* sp., *Leptospermum lævigatum*, *Melaleuca ericifolia*, &c. (Victoria; New South Wales).

Chionaspis eugeniæ, Maskell, var.—Maskell, N.Z. Trans., 1892, p. 211.

Hab. In Australia, on *Eucalyptus* sp. (Victoria).

Chionaspis minor, Maskell.—Maskell, N.Z. Trans., 1884, p. 33; Scale-Insects of N.Z., 1887, p. 56. Cockerell, Ent. Mo. Mag., 1893, p. 38.

Hab. In New Zealand, on *Parsonsia* sp., *Rhipogonum scandens* (passim); in Jamaica, on palm.

Chionaspis nitida, Maskell.—Maskell, N.Z. Trans., 1891, p. 15.

Hab. In Australia, on *Daviesia corymbosa* (Victoria; South Australia).

Chionaspis prunicola, Maskell.—Maskell, N.Z. Trans., 1894, p. 49.

Hab. In Sandwich Islands, on "Japanese plum."

Chionaspis xerotidis, Maskell.—Maskell, N.Z. Trans., 1894, p. 50.

Hab. In Australia, on *Xerotes longifolia* (New South Wales).

Genus **Fiorinia**, Targioni-Tozzetti.

This genus has hitherto been reported, in the open air, from New Zealand and Australia. It exists in hothouses in Europe and North America.

Fiorinia acaciæ, Maskell.—Maskell, N.Z. Trans., 1881, p. 16,

Hab. In Australia, on *Acacia pycnantha* (South Australia).

Fiorinia asteliæ, Maskell. *Diaspis gigas*, Maskell.—Maskell, N.Z. Trans., 1878, p. 201; ib., 1881, p. 217; ib., 1884, p. 24; ib., 1889, p. 137; Scale-Insects of N.Z., 1887, p. 58.

Hab. In New Zealand, on *Atherosperma novæ-zealandiæ*, *Astelia cunninghamii*, *Coprosma* var. sp., *Pittosporum eugenioide*, &c. (passim).

Fiorinia camelliæ, Comstock.—Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 329; Maskell, N.Z. Trans., 1891, p. 16; ib., 1892, p. 211.

Hab. In Australia, on *Livistonia* sp., and various palms and on *Leptospermum* sp. (New South Wales); in North America, on camellia and palms.

FIORINIA EXPANSA, Maskell.—Maskell, N.Z. Trans., 1894, p. 51.

Hab. In Australia, on *Melaleuca linariifolia* (New South Wales).

FIORINIA GROSSULARIÆ, Maskell.—Maskell, N.Z. Trans., 1883, p. 123; Scale-Insects of N.Z., 1887, p. 59.

Hab. In New Zealand, on *Ribes grossularia*.

FIORINIA MINIMA, Maskell.—Maskell, N.Z. Trans., 1883, p. 122; Scale-Insects of N.Z., 1887, p. 59.

Hab. In New Zealand, on *Brachyglottis repanda* (Canterbury).

FIORINIA RUBRA, Maskell.—Maskell, N.Z. Trans., 1893, p. 71.

Hab. In Australia, on *Acacia* sp. (Western Australia).

FIORINIA STRICTA, Maskell.—Maskell, N.Z. Trans., 1883, p. 124; ib., 1884, p. 24; ib., 1894, p. 51; Scale-Insects of N.Z., 1887, p. 60.

Hab. In New Zealand, on *Dendrobium* sp., *Hedycarya* sp.; *Phormium tenax*, *Cordyline australis*, *Astelia cunninghamii*, *Muhlenbeckia* sp., *Hoheria angustifolia*, &c. (passim).

FIORINIA SYNCARPIÆ, Maskell.—Maskell, N.Z. Trans., 1892, p. 212.

Hab. In Australia, on *Syncarpia laurifolia* (New South Wales).

Genus **Ischnaspis**, Douglas.

This genus has hitherto been reported only from the West Indies, Demerara, and Mexico.

ISCHNASPIS FILIFORMIS, Douglas.—Douglas, Ent. Mo. Mag., 1887, p. 21. Maskell, N.Z. Trans., 1894, p. 52.

Hab. In Australia, on palms in greenhouses (South Australia).

Sub-family LECANINÆ.

Section LECANODIASPIDÆ, Maskell.

Genus **Lecanochiton.**

This genus has been reported only from New Zealand.

LECANOCHITON METROSIDERI, Maskell.—Maskell, N.Z. Trans., 1881, p. 222; ib., 1883, p. 129; Scale-Insects of N.Z., 1887, p. 64.

Hab. In New Zealand, on *Metrosideros robusta*, *Metrosideros tomentosa* (Otago; Auckland).

LECANOCHITON MINOR, Maskell.—Maskell, N.Z. Trans., 1890, p. 12.

Hab. In New Zealand, on *Metrosideros robusta* (Reefton).

Genus **Ceroplastes**, Gray.

This genus has been reported from Europe, North and South America, India, Africa, and Australia.

Ceroplastes australasiæ, Walker.—Walker, List of Homopt. in Brit. Mus., 1087. Signoret, Ann. de la Soc. Ent. de France, 1872, p. 45.

Hab. In Australia, on (?) (New South Wales).

Ceroplastes ceriferus, Anderson.—Anderson, Monograph of *Coccus ceriferus*, 1791. Westwood, Gard. Chron., 1853, 484. Signoret, Ann. de la Soc. Ent. de France, 1872, p. 40. Maskell, N.Z. Trans., 1892, p. 216.

Hab. In Australia, on *Melaleuca hypericifolia*, *Myrica cerifera*, *Pteris* sp., &c. (New South Wales); in India, on *Celastrus* sp., &c.

Ceroplastes rubens, Maskell.—Maskell, N.Z. Trans., 1892, p. 214.

Hab. In Australia, on *Mangifera indica*, *Ficus macrophylla* (Queensland).

Genus **Ctenochiton**, Maskell.

This genus, up to the present time, is confined to New Zealand and Australia.

Ctenochiton dacrydii, Maskell.—Maskell, N.Z. Trans., 1891, p. 18.

Hab. In New Zealand, on *Dacrydium cupressinum* (Reefton).

Ctenochiton depressus, Maskell. — Maskell, N.Z. Trans., 1883, p. 132; Scale-Insects of N.Z., 1887, p. 66.

Hab. In New Zealand, on *Plagianthus*, *Cyathea*, &c. (Hawke's Bay).

Ctenochiton depressus, Maskell, *forma minor*. — Maskell, N.Z. Trans., 1891, p. 19.

Hab. In New Zealand, on *Coprosma* sp. (Reefton).

Ctenochiton elæocarpi, Maskell.—Maskell, N.Z. Trans., 1884, p. 26; ib., 1891, p. 17; Scale-Insects of N.Z., 1887, p. 67.

Hab. In New Zealand, on *Elæocarpus dentatus* (Wellington).

Ctenochiton elongatus, Maskell.—Maskell, N.Z. Trans., 1878, p. 212; Scale-Insects of N.Z., 1887, p. 68.

Hab. In New Zealand, on *Geniostoma ligustrifolium*, *Dendrobium* sp., *Earina* sp. (Auckland; Hawke's Bay; Wellington).

Ctenochiton eucalypti, Maskell.—Maskell, N.Z. Trans., 1894, p. 52.

Hab. In Australia, on *Eucalyptus siderophloia* (New South Wales).

Ctenochiton flavus, Maskell.—Maskell, N.Z. Trans., 1883, p. 130; ib., 1884, p. 26; Scale-Insects of N.Z., 1887, p. 68.

Hab. In New Zealand, on *Brachyglottis repanda, Panax arboreum, Leptospermum scoparium, Elæocarpus dentatus* (Wellington).

Ctenochiton fuscus, Maskell.—Maskell, N.Z. Trans., 1883, p. 131; Scale-Insects of N.Z., 1887, p. 70.

Hab. In New Zealand, on *Brachyglottis repanda, Panax arboreum* (Canterbury).

Ctenochiton hymenantheræ, Maskell. — Maskell, N.Z. Trans., 1884, p. 25; Scale-Insects of N.Z., 1887, p. 71.

Hab. In New Zealand, on *Hymenanthera crassifolia* (Wellington).

Ctenochiton perforatus, Maskell.—Maskell, N.Z. Trans., 1878, p. 280; ib., 1883, p. 130; Scale-Insects of N.Z., 1887, p. 72.

Hab. In New Zealand, on *Pittosporum eugenioide, Panax arboreum, Coprosma lucida, Rubus australis* (Wellington; Nelson; Canterbury; Otago).

Ctenochiton piperis, Maskell.—Maskell, N.Z. Trans., 1881, p. 218; ib., 1884, p. 25; Scale-Insects of N.Z., 1887, p. 73.

Hab. in New Zealand, on *Piper excelsum* (Auckland; Hawke's Bay; Wellington).

Ctenochiton rhizophoræ, Maskell.—Maskell, N.Z. Trans., 1894, p. 54.

Hab. In Australia, on *Rhizophora mangle* (Queensland).

Ctenochiton viridis, Maskell.—Maskell, N.Z. Trans., 1878, p. 211; ib., 1884, p. 24; Scale-Insects of N.Z., 1887, p. 74.

Hab. In New Zealand, on *Panax arboreum, Coprosma lucida, Hedycarya dentata, Atherosperma novæ-zealandiæ, Rubus australis* (passim).

Genus **Inglisia**, Maskell.

This genus has only been reported from New Zealand, Australia, and Trinidad (West Indies).

Inglisia fagi, Maskell.—Maskell, N.Z. Trans., 1890, p. 13.

Hab. In New Zealand, on *Fagus*, var. sp. (Reefton).

Inglisia foraminifer, Maskell.—Maskell, N.Z. Trans., 1892, p. 213.

Hab. In Australia, on *Santalum acuminatum* (South Australia).

Inglisia inconspicua, Maskell.—Maskell, N.Z. Trans., 1891, p. 19.

Hab. In New Zealand, on *Corokia cotoneaster* (Reefton).

Inglisia leptospermi, Maskell.—Maskell, N.Z. Trans., 1881, p. 220; ib., 1884, p. 27; Scale-Insects of N.Z., 1887, p. 75.

Hab. In New Zealand, on *Leptospermum scoparium* (passim).

Inglisia ornata, Maskell.—Maskell, N.Z. Trans., 1884, p. 27; Scale-Insects of N.Z., 1887, p. 76.

Hab. In New Zealand, on *Elæocarpus dentatus, Leptospermum scoparium* (Wellington); males sometimes on *Coprosma, Pittosporum*, &c.

Inglisia patella, Maskell.—Maskell, N.Z. Trans., 1878, p. 213; ib., 1881, p. 219; Scale-Insects of N.Z., p. 78.

Hab. In New Zealand, on *Coprosma lucida, Drimys colorata, Atherosperma novæ-zealandiæ* (Wellington; Canterbury).

Genus **Ceronema**, Maskell.

This genus is as yet reported only from Australia.

Ceronema banksiæ, Maskell.—Maskell, N.Z. Trans., 1894, p. 56.

Hab. In Australia, on *Banksia serrata* (New South Wales).

Section LECANIDÆ.

Genus **Lecanium**, Illiger.

This genus is cosmopolitan.

Lecanium acuminatum, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1873, p. 397. Maskell, N.Z. Trans., 1892, p. 219.

Hab. In Sandwich Islands, on *Psidium* sp.; in Europe, on hothouse orchids.

Lecanium alienum, Douglas.—Douglas, Ent. Mo. Mag., 1886, p. 77.

Hab. In Europe, on *Asplenium bulbiferum* (New Zealand fern).

Lecanium anthurii, Boisduval.—Boisduval, Ent. Hort., 1867, 329. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 435. Maskell, N.Z. Trans., 1892, p. 219.

Hab. In Australia, on *Asparagus* sp. (Victoria); in Europe, on hothouse epiphyte.

LECANIUM BACCATUM, Maskell.—Maskell, N.Z. Trans., 1891, p. 20; ib., 1892, p. 217.

Hab. In Australia, on *Acacia armata* (South Australia), *Acacia calamifolia*, *Acacia longifolia* (Victoria).

LECANIUM CASSINIÆ, Maskell.—Maskell, N.Z. Trans., 1890, p. 15.

Hab. In New Zealand, on *Cassinia leptophylla* (Wellington).

LECANIUM FILICUM, Boisduval.—Boisduval, Ent. Hort., 1867, 336. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 436. Maskell, N.Z. Trans., 1892, p. 220.

Hab. In Australia, on *Lomaria* (?) sp. (New South Wales); in Europe, on hothouse fern, *Pteris argirea.*

LECANIUM FRENCHII, Maskell.—Maskell, N.Z. Trans., 1890, p. 17.

Hab. In Australia, on *Banksia australis* (Victoria).

LECANIUM HEMISPHÆRICUM, Targioni-Tozzetti. — Targioni, Stud. sulle Coccineglie, 1867, p. 27. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 436. Maskell, N.Z. Trans., 1884, p. 29; ib., 1894, p. 59; Scale-Insects of N.Z., 1887, p. 80.

Hab. In New Zealand, on *Camellia japonica* (Wellington); in Europe, on *Dracæna australis;* in North America, on various greenhouse plants; in Australia, on hothouse plants (South Australia).

LECANIUM HESPERIDUM, Linnæus.—Linnæus, Syst. Nat., 1735, ii., 739. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 399. Maskell, N.Z. Trans., 1878, p. 205; ib., 1892, p. 218; Scale-Insects of N.Z., 1887, p. 80.

Hab. In New Zealand, on *Laurus*, *Ilex*, *Hedera*, *Citrus*, *Camellia*, *Myrtus*, *Buxus*, &c.; in Australia, on *Citrus*, *Laurus*, &c.

LECANIUM HIBERNACULORUM, Boisduval. — Boisduval, Ent. Hort., 1867, p. 337. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 437. Maskell, N.Z. Trans., 1878, p. 207; Scale-Insects of N.Z., 1887, p. 81.

Hab. In New Zealand, on various greenhouse plants (Canterbury); in Europe, on hothouse plants.

LECANIUM LONGULUM, Douglas. *Lecanium chirimoliæ*, Maskell.—Douglas, Ent. Mo. Mag., 1887, p. 97. Maskell, N.Z. Trans., 1889, p. 137; ib., 1890, p. 16; ib., 1892, p. 221.

Hab. In Fiji, on *Annona tripetala;* in Sandwich Islands, on *Psidium*, *Bambusa*, *Citrus*, *Acacia*, &c.; in Demerara, on *Annona muricata*, &c.

Lecanium maculatum, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1873, p. 400. Maskell, N.Z. Trans., 1878, p. 207; Scale-Insects of N.Z., 1887, p. 81.

Hab. In New Zealand, on *Bavardia* (Canterbury); in Europe, on *Hedera*.

Lecanium mori, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1873, p. 407. Maskell, N.Z. Trans., 1884, p. 29; ib., 1893, p. 75; Scale-Insects of N.Z., 1887, p. 82.

Hab. In New Zealand, on *Alsophila colensoi*, *Nephrolepis cordifolia*, *Asplenium flaccidum*, &c.; in Europe, on *Morus albus*.

Lecanium nigrum, Nietner, var. *depressum*, Targioni-Tozzetti.—Nietner, "Enemies of the Coffee-tree," 1861. Targioni, Stud. sulle Coccineglie, 1867, p. 29. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 439. Douglas, Ent. Mo. Mag., 1887, p. 27. Maskell, N.Z. Trans., 1878, p. 206; ib., 1892, p. 220; ib., 1893, p. 73; Scale-Insects of N.Z., 1887, p. 79.

Hab. In New Zealand, on various greenhouse plants; in Australia, on *Hakea* sp., and on "unnamed plant," and on "cultivated vine" (New South Wales); in Sandwich Islands, on *Psidium* sp., *Bambusa* sp.

Lecanium oleæ, Bernard.—Bernard, Mem. d'Hist. Nat. Acad., 1872, p. 108. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 440. Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 336. Maskell, N.Z. Trans., 1884, p. 28; Scale-Insects of N.Z., 1887, p. 82.

Hab. In New Zealand, on *Camellia japonica*, and on "native trees" (Wellington; Hawke's Bay; Auckland); in Sandwich Islands, on *Citrus*, *Psidium*, &c.; in North America, on *Citrus*, *Olea*, &c.; in Europe, on *Olea*.

Lecanium patersoniæ, Maskell.—Maskell, N.Z. Trans., 1894, p. 57.

Hab. In Australia, on *Patersonia glabrata* (New South Wales).

Lecanium pingue, Maskell.—Maskell, N.Z. Trans., 1894, p. 58.

Hab. In Australia, on *Dillwynia juniperina* (New South Wales).

Lecanium ribis, Fitch.—Fitch, Trans. New York Agric. Soc., 1856. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 624. Maskell, N.Z. Trans., 1890, p. 16; ib., 1891, p. 22.

Hab. In New Zealand, on *Ribes* sp. (gooseberries and currants); in North America, on the same.

LECANIUM ROSARUM, Snellen van Vollenhoven.—Snellen van Vollenhoven, Tijdschrift voor Ent. v., 94. Signoret, Ann. de la Soc. Ent. de France, 1873, p. 427. Maskell, N.Z. Trans., 1891, p. 22.

Hab. In Australia, on *Ribes grossularia* (gooseberry), and on *Rosa;* in Europe, on *Rosa;* perhaps in New Zealand, on *Vitis*.

LECANIUM SCROBICULATUM, Maskell.—Maskell, N.Z. Trans., 1892, p. 221; ib., 1894, p. 58.

Hab. In Australia, on *Acacia* sp. (New South Wales).

LECANIUM TESSELLATUM, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1873, p. 401. Maskell, N.Z. Trans., 1892, p. 219; ib., 1894, p. 59.

Hab. In Australia, on *Laurus nobilis* (New South Wales); in Europe, on palms in hothouses; in South Australia, on palms.

LECANIUM (?) sp., Maskell.—Maskell, N.Z. Trans., 1893, p. 72.

Hab. In Australia, on *Casuarina* sp. (New South Wales).

NOTE.—The following have been omitted from the foregoing list, as nobody seems to know anything about them or their food-plants, beyond the original names: LECANIUM AUSTRALE, Walker (Tasmania); LECANIUM ORBICULARE, Targioni-Tozzetti (Australia); LECANIUM VIRGATUM, Targioni-Tozzetti (Australia).

Genus **Lecanopsis**, Targioni-Tozzetti.

LECANOPSIS FILICUM, Maskell.—Maskell, Proc. of Linn. Soc. New South Wales, 1893, p. 225.

Hab. In Australia, on *Doodia aspera*, underground (New South Wales).

Genus **Pulvinaria**, Targioni-Tozzetti.

This genus has been reported from Europe, North America, West Indies, Australia, India, New Zealand, and Sandwich Islands.

PULVINARIA CAMELLICOLA, Signoret.—Signoret, Ann. de la Soc. Ent. de France, 1872, p. 208. Maskell, N.Z. Trans., 1878, p. 207.

Hab. In New Zealand, on *Camellia japonica;* in Europe, on the same.

PULVINARIA DODONÆÆ, Maskell.—Maskell, N.Z. Trans., 1892, p. 222.

Hab. In Australia, on *Dodonæa bursarifolia* and on *Myoporum* sp. (South Australia).

Pulvinaria flavicans, Maskell.—Maskell, Trans. Roy. Soc. South Australia, 1887–88, p. 103.

Hab. In Australia, on (?) (South Australia).

Pulvinaria mammeæ, Maskell.—Maskell, N.Z. Trans., 1894, p. 59.

Hab. In Sandwich Islands, on *Mammea americana.*

Pulvinaria maskelli, Olliff. *Signoretia atriplicis*, Maskell. —Olliff, Agric. Gaz. New South Wales, 1891, p. 667; ib., 1892, p. 176. Maskell, N.Z. Trans., 1891, p. 23; ib., 1893, p. 76.

Hab. In Australia, on *Atriplex nummularia*, *Rhagodia hastata* (New South Wales).

Pulvinaria maskelli, Olliff, var. *spinosior*, Maskell. — Maskell, N.Z. Trans., 1893, p. 78.

Hab. In Australia, on *Frenela (Callitris) robusta* (South Australia).

Pulvinaria psidii, Maskell. — Maskell, N.Z. Trans., 1892, p. 223.

Hab. In Sandwich Islands, on *Psidium cattleyanum.*

Pulvinaria tecta, Maskell. — Maskell, N.Z. Trans., 1893, p. 79.

Hab. In Australia, on *Citrus*, *Acacia* sp., *Daviesia corymbosa* (Victoria; New South Wales).

Section LECANOCOCCIDÆ, Maskell.

Genus **Signoretia**, Targioni-Tozzetti.

This genus has been reported only from Europe and Australia.

Signoretia luzulæ, Dufour, var. *australis*, Maskell. — Maskell, N.Z. Trans., 1892, p. 223; ib., 1893, p. 80.

Hab. In Australia, on grass (New South Wales).

Genus **Eriochiton**, Maskell.

This genus has only been reported from New Zealand and India.

Eriochiton hispidus, Maskell.—Maskell, N.Z. Trans., 1886, p. 47; Scale-Insects of N.Z., 1887, p. 84.

Hab. In New Zealand, on *Olearia haastii* (Southern Alps).

Eriochiton spinosus, Maskell. *Ctenochiton spinosus*, Maskell.—Maskell, N.Z. Trans., 1878, p. 212; ib., 1879, p. 292; ib., 1881, p. 218; ib., 1884, p. 25; Scale-Insects of N.Z., 1887, p. 86.

Hab. In New Zealand, on *Atherosperma novæ-zealandiæ*,

Melicope ternata, Elæocarpus dentatus, Muhlenbeckia adspersa (Wellington; Canterbury).

Sub-family HEMICOCCINÆ, Maskell.

Section KERMITIDÆ, Maskell.

Genus **Kermes**, auctorum.

This genus has been reported from Europe, North America, Algeria, and Australia.

KERMES ACACIÆ, Maskell.—Maskell, N.Z. Trans., 1893, p. 83.
Hab. In Australia, on *Acacia* sp. (New South Wales).

Sub-family COCCINÆ.

Section ACANTHOCOCCIDÆ.

Genus **Solenophora**, Maskell.

This genus has only been reported from New Zealand.

SOLENOPHORA COROKIÆ, Maskell.—Maskell, N.Z. Trans., 1889, p. 141; ib., 1890, p. 18.
Hab. In New Zealand, on *Corokia cotoneaster* (Reefton).

SOLENOPHORA FAGI, Maskell.—Maskell, N.Z. Trans., 1889, p. 139.
Hab. In New Zealand, on *Fagus*, var. sp. (Inangahua).

Genus **Prosopophora**, Douglas.

This genus has been reported only from North America, Demerara, and Australia.

PROSOPOPHORA ACACIÆ, Maskell.—Maskell, N.Z. Trans., 1892, p. 225.
Hab. In Australia, on *Acacia calamifolia* (South Australia).

PROSOPOPHORA EUCALYPTI, Maskell.—Maskell, N.Z. Trans., 1892, p. 226.
Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Genus **Planchonia**, Signoret.

This genus appears to be nearly cosmopolitan.

PLANCHONIA BRYOIDES, Maskell.—Maskell, N.Z. Trans., 1893, p. 84.
Hab. In Fiji, on (?).

PLANCHONIA EPACRIDIS, Maskell.—Maskell, N.Z. Trans., 1881, p. 224; Scale-Insects of N.Z., 1887, p. 91.
Hab. In New Zealand, on *Leucopogon fraseri* (Canterbury).

Planchonia fimbriata, Boyer de Fonscolombe.—Boyer de Fonscolombe, Ann. de la Soc. Ent. de France, 1834, p. 209; Signoret, Ann. de la Soc. Ent. de France, 1868, p. 283; Maskell, N.Z. Trans., 1893, p. 85; ib., 1894, pp. 61, 62.

Hab. In Australia, on *Leptospermum flavescens* (Queensland).

Planchonia styphelieæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 24; ib., 1893, p. 85; ib., 1894, p. 62.

Hab. In Australia, on *Styphelia richei*, *Leptospermum juniperinum* (Victoria); in Tasmania, on *Melaleuca* sp.

Planchonia ventruosa, Maskell. — Maskell, N.Z. Trans., 1894, p. 63.

Hab. In Australia, on *Acacia* sp. (New South Wales; South Australia).

Genus **Rhizococcus**, Signoret.

This genus has been reported from Europe, North America, Australia, and New Zealand.

Rhizococcus casuarinæ, Maskell. — Maskell, N.Z. Trans., 1892, p. 230.

Hab. In Australia, on *Casuarina suberosa* (Victoria).

Rhizococcus celmisiæ, Maskell.—Maskell, N.Z. Trans., 1883, p. 135; Scale-Insects of N.Z., 1887, p. 96.

Hab. In New Zealand, on *Celmisia* sp. (Southern Alps).

Rhizococcus fossor, Maskell.—Maskell, N.Z. Trans., 1883, p. 136; Scale-Insects of N.Z., p. 97.

Hab. In New Zealand, on *Santalum cunninghamii* (Hawke's Bay).

Rhizococcus grandis, Maskell.—Maskell, N.Z. Trans., 1891, p. 29.

Hab. In Australia, on *Acacia longifolia* (Victoria).

Rhizococcus grandis, Maskell, var. *spinosior*, Maskell. — Maskell, N.Z. Trans., 1892, p. 230.

Hab. In Australia, on *Acacia implexa* (Victoria).

Rhizococcus intermedius, Maskell.—Maskell, N.Z. Trans., 1890, p. 19.

Hab. In New Zealand, on *Fagus menziesii* (Reefton).

Rhizococcus maculatus, Maskell.—Maskell, N.Z. Trans., 1889, p. 144.

Hab. In New Zealand, on *Fagus cliffortioides* (Reefton).

Rhizococcus pulchellus, Maskell. — N.Z. Trans., 1889, p. 143.

Hab. In New Zealand, on *Fagus fusca, Fagus menziesii, Fagus cliffortioides* (Wellington; Marlborough; Reefton).

Rhizococcus pustulatus, Maskell. — Maskell, N.Z. Trans., 1892, p. 231.

Hab. In Australia, on *Casuarina* sp. (Victoria).

Rhizococcus totaræ, Maskell.— Maskell, N.Z. Trans., 1889, p. 142; ib., 1890, p. 19.

Hab. In New Zealand, on *Podocarpus totara, Fagus menziesii* (Reefton).

Genus **Gossyparia**, Signoret.

This genus has been reported from Europe, Arabia, North America, Australia, and New Zealand.

Gossyparia casuarinæ, Maskell.—Maskell, N.Z. Trans., 1892, p. 227.

Hab. In Australia, on *Casuarina* sp. (New South Wales).

Gossyparia cavellii, Maskell.—Maskell, N.Z. Trans., 1889, p. 147.

Hab. In New Zealand, on *Fagus menziesii* (Wellington; Reefton).

Gossyparia confluens, Maskell.—Maskell, N.Z. Trans., 1892, p. 227.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Genus **Eriococcus**, Targioni-Tozzetti.

This genus has been reported from Europe, North America, Australia, and New Zealand.

Eriococcus araucariæ, Maskell.—Maskell, N.Z. Trans., 1878, p. 218; ib., 1883, p. 134; Scale-Insects of N.Z., p. 93. Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 339 (sub nomine *Rhizococcus*).

Hab. In New Zealand, on *Araucaria excelsa* (Canterbury); in North America, on the same.

Eriococcus araucariæ, Maskell, var. *minor*, Maskell.— Maskell, N.Z. Trans., 1894, p. 64.

Hab. In Australia, on *Kunzea* sp. (New South Wales).

Eriococcus buxi, Boyer de Fonscolombe, var. *australis*, Maskell.—Boyer de Fonscolombe, Ann. de la Soc. Ent. de France, 1834, p. 218. Signoret, Ann. de la Soc. Ent. de France, 1874, p. 30. Maskell, N.Z. Trans., 1894, p. 65.

Hab. In Australia, on (?) (Botanic Gardens, Brisbane).

Eriococcus confusus, Maskell.—Maskell, N.Z. Trans., 1891, p. 26.

Hab. In Australia, on *Eucalyptus viminalis* (Victoria).

Eriococcus conspersus, Maskell.—Maskell, N.Z. Trans., 1892, p. 229.

Hab. In Australia, on *Casuarina* sp. (New South Wales).

Eriococcus coriaceus, Maskell.—Maskell, N.Z. Trans., 1892, p. 229.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Eriococcus danthoniæ, Maskell.—Maskell, N.Z. Trans., 1890, p. 21.

Hab. In New Zealand, on *Danthonia cunninghamii* (Reefton).

Eriococcus eucalypti, Maskell.—Maskell, N.Z. Trans., 1891, p. 27.

Hab. In Australia, on *Eucalyptus diversicolor*, *Bursaria spinosa* (South Australia; Victoria).

Eriococcus fagicorticis, Maskell.—Maskell, N.Z. Trans., 1891, p. 27.

Hab. In New Zealand, on *Fagus fusca* (Reefton).

Eriococcus hoheriæ, Maskell.—Maskell, N.Z. Trans., 1879, p. 298; ib., 1890, p. 20; ib., 1891, p. 26; Scale-Insects of N.Z., 1887, p. 93.

Hab. In New Zealand, on *Hoheria angustifolia* (Canterbury).

Eriococcus leptospermi, Maskell.—Maskell, N.Z. Trans., 1890, p. 22.

Hab. In Australia, on *Leptospermum lævigatum* (Victoria).

Eriococcus multispinus, Maskell. *Acanthococcus multispinus*, Maskell.—Maskell, N.Z. Trans., 1878, p. 217; ib., 1879, p. 292; ib., 1884, p. 29; Scale-Insects of N.Z., 1887, p. 94.

Hab. In New Zealand, on *Rubus australis*, *Knightia excelsa*, *Cyathodes acerosa* (Canterbury; Wellington).

Eriococcus multispinus, Maskell, var. *lævigatus*, Maskell.—Maskell, N.Z. Trans., 1890, p. 20.

Hab. In Australia, on *Acacia armata* (Victoria).

Eriococcus pallidus, Maskell.—Maskell, N.Z. Trans., 1884, p. 29; ib., 1890, p. 21; Scale-Insects of N.Z., 1887, p. 95.

Hab. In New Zealand, on *Myoporum lætum*, *Elæocarpus dentatus*, *Fagus menziesii*, *Atherosperma novæ-zealandiæ* (passim).

Eriococcus paradoxus, Maskell.—Maskell, Trans. Roy. Soc. South Australia, 1887–88, p. 104.

Hab. In Australia, on *Pittosporum undulatum* (South Australia).

Eriococcus phyllocladi, Maskell.—Maskell, N.Z. Trans., 1891, p. 25.

Hab. In New Zealand, on *Phyllocladus trichomanoides* (Reefton).

Eriococcus raithbyi, Maskell.—Maskell, N.Z. Trans., 1889, p. 145.

Hab. In New Zealand, on *Fagus menziesii* (Reefton).

Eriococcus tepperi, Maskell.—Maskell, N.Z. Trans., 1891, p. 29.

Hab. In Australia, on *Eucalyptus globulus, Bursaria spinosa* (South Australia; Tasmania).

Eriococcus turgipes, Maskell.—Maskell, N.Z. Trans., 1892, p. 228.

Hab. In Australia, on *Casuarina* sp. (New South Wales).

Section DACTYLOPIDÆ, Maskell.

Genus **Coccus**, auctorum.

This genus has been reported from Mexico and (where cultivated as cochineal) Spain, Algiers, &c.; also from Australia.

Coccus blanchardii, Targioni-Tozzetti. — Targioni-Tozzetti, Catal., 1868, p. 32.

Hab. In Australia, on (?).

Genus **Ripersia**, Signoret.

This genus has been reported from Europe, Australia, and New Zealand.

Ripersia fagi, Maskell.—Maskell, N.Z. Trans., 1890, p. 24.

Hab. In New Zealand, on *Fagus menziesii* (Reefton).

Ripersia formicicola, Maskell.—Maskell, N.Z. Trans., 1891, p. 38.

Hab. In New Zealand, in ants' nests, subterranean (Canterbury).

Ripersia leptospermi, Maskell.—Maskell, Trans., Roy. Soc., South Australia, 1887–88, p. 106.

Hab. In Australia, on *Leptospermum lævigatum* (South Australia).

Ripersia rumicis, Maskell. — Maskell, N.Z. Trans., 1891 p. 37.

Hab. In New Zealand, on *Rumex acetosella*, subterranean (Reefton).

Genus **Dactylopius**, Costa.

This genus is cosmopolitan.

Dactylopius acaciæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 33.

Hab. In Australia, on *Acacia linearis*, *Acacia lophantha* (Victoria).

Dactylopius adonidum, Linnæus. *Coccus adonidum*, Linnæus, Syst. Nat., 1767, p. 740. *Dactylopius adonidum*, Targioni-Tozzetti, Catal., 1868, p. 32.—Signoret, Ann. de la Soc. Ent. de France, 1874, p. 306. Comstock, Ent. Rep. U.S. Dept. Agric., 1880, p. 341. Maskell, N.Z. Trans., 1889, p. 150.

Hab. In Australia and New Zealand, in greenhouses (passim).

Dactylopius affinis, Maskell.—Maskell, N.Z. Trans., 1893, p. 90.

Hab. In Australia, on tubers of dahlia and potato, underground (New South Wales).

Dactylopius albizziæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 31.

Hab. In Australia, on *Albizzia lophantha* (Victoria; the tree is West Australian).

Dactylopius alpinus, Maskell.—Maskell, N.Z. Trans., 1883, p. 138; Scale-Insects of N.Z., 1887, p. 99.

Hab. In New Zealand, on *Veronica* sp. (Southern Alps).

Dactylopius arecæ, Maskell.—Maskell, N.Z. Trans., 1889, p. 150; ib., 1892, p. 231.

Hab. In New Zealand, on roots of *Areca sapida*, *Ribes grossularia*, various *Gramineæ*, &c., underground (Wellington; Canterbury).

Dactylopius aurilanatus, Maskell.—Maskell, N.Z. Trans., 1889, p. 151.

Hab. In New Zealand, on *Araucaria bidwillii*, *Araucaria excelsa* (Auckland).

Dactylopius calceolariæ, Maskell.—Maskell, N.Z. Trans., 1878, p. 218; ib., 1883, p. 138; ib., 1889, p. 149; ib., 1893, p. 89; Scale-Insects of N.Z., 1887, p. 100.

Hab. In New Zealand, on *Calceolaria* sp., *Cordyline australis*, *Danthonia cunninghamii*, *Phormium tenax* (Hawke's

Bay; Canterbury; Stewart Island); in Fiji, on *Saccharum officinarum* (sugar-cane).

DACTYLOPIUS COCOTIS, Maskell.—Maskell, N.Z. Trans., 1889, p. 149; ib., 1891, p. 34.

Hab. In Fiji, on *Cocos nucifera*; in Laccadive Islands, on the same.

DACTYLOPIUS ERICICOLA, Maskell.—Maskell, N.Z. Trans., 1892, p. 232.

Hab. In Australia, on *Erica autumnalis* (Victoria); the plant is from the Cape of Good Hope).

DACTYLOPIUS EUCALYPTI, Maskell.—Maskell, N.Z. Trans., 1891, p. 35; ib., 1892, p. 233; ib., 1893, p. 90; ib., 1894, p. 65.

Hab. In Australia, on *Eucalyptus rostrata, Eucalyptus robusta* (South Australia; New South Wales).

DACTYLOPIUS GLAUCUS, Maskell.—Maskell, N.Z. Trans., 1878, p. 219; ib., 1884, p. 30; Scale-Insects of N.Z., 1887, p. 100.

Hab. In New Zealand, on *Panax arboreum, Rubus australis, Coprosma* var. sp., *Pittosporum eugenioide, Piper excelsum*, &c. (passim).

DACTYLOPIUS GLOBOSUS, Maskell.—Maskell, N.Z. Trans., 1891, p. 34.

Hab. In Australia, on *Acacia armata, Acacia decurrens* (South Australia; Victoria).

DACTYLOPIUS HERBICOLA, Maskell.—Maskell, Agric. Gaz., New South Wales, 1891, p. 352; N.Z. Trans., 1891, p. 36.

Hab. In Australia, on *Aristida vagans* (New South Wales).

DACTYLOPIUS HIBBERTIÆ, Maskell.—Maskell, N.Z. Trans., 1891, p. 32.

Hab. In Australia, on *Hibbertia virgata, Hibbertia linearis* (South Australia; Victoria).

DACTYLOPIUS ICERYOIDES, Maskell.—Maskell, N.Z. Trans., 1891, p. 33.

Hab. In New Zealand, on *Fagus fusca* (Reefton).

DACTYLOPIUS LILIACEARUM, Bouché.—Bouché, Ent. Zeit. Stett., 1844, 293. Signoret, Ann. de la Soc. Ent. de France, 1874, p. 319.

Hab. In Europe, on Australian *Liliaceæ, Crinum* sp.

DACTYLOPIUS LOBULATUS, Maskell.—Maskell, N.Z. Trans., 1893, p. 91.

Hab. In Australia, on *Eucalyptus globulus* (Victoria; the tree is Tasmanian).

Dactylopius obtectus, Maskell.—Maskell, N.Z. Trans., 1889, p. 152.

Hab. In New Zealand, on *Fagus fusca* (Reefton).

Dactylopius poæ, Maskell.—Maskell, N.Z. Trans., 1878, p. 220; ib., 1889, p. 150; ib., 1890, p. 23; ib., 1893, p. 89; Scale-Insects of N.Z., 1887, p. 101.

Hab. In New Zealand, on roots of grass or trees, underground or just above surface (passim).

Dactylopius vastator, Maskell.—Maskell, N.Z. Trans., 1894, p. 65.

Hab. In Sandwich Islands, on *Citrus* and many other trees (perhaps originally Japan).

Dactylopius zamiæ, Lucas.—Lucas, Ann. de la Soc. Ent. de France, 1855, p. 107. Signoret, Ann. de la Soc. Ent. de France, 1874, p. 328.

Hab. In Australia, on *Zamia (Encephalartos) spiralis.*

Genus **Pseudococcus**, Westwood.

This genus has been reported from Europe, North America, Australia, and New Zealand.

Pseudococcus astelie, Maskell.—Maskell, N.Z. Trans., 1883, p. 139; Scale-Insects of N.Z., 1887, p. 102.

Hab. In New Zealand, on *Astelia* sp. (Hawke's Bay).

Pseudococcus casuarinæ, Maskell.—Maskell, N.Z. Trans., 1892, p. 235.

Hab. In Australia, on *Casuarina* sp. (Victoria).

Pseudococcus nivalis, Maskell.—Maskell, N.Z. Trans., 1892, p. 234.

Hab. In Australia, on *Acacia* sp. (New South Wales).

Section IDIOCOCCIDÆ, Maskell.

Genus **Sphærococcus**, Maskell.

This genus has been reported only from Australia and the Sandwich Islands.

Sphærococcus acaciæ, Maskell.—Maskell, N.Z. Trans., 1892, p. 237.

Hab. In Australia, on *Acacia* sp. (New South Wales).

Sphærococcus bambusæ, Maskell.—Maskell, N.Z. Trans., 1892, p. 237.

Hab. In Sandwich Islands, on *Bambusa* sp.

Sphærococcus casuarinæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 39.

Hab. In Australia, on *Casuarina quadrivalvis* (Victoria).

Sphærococcus elevans, Maskell.—Maskell, N.Z. Trans., 1894, p. 68.

Hab. In Australia, on *Eucalyptus dumosa* (Victoria).

Sphærococcus froggatti, Maskell.—Maskell, N.Z. Trans., 1893, p. 94.

Hab. In Australia, on *Melaleuca linariifolia* (New South Wales).

Sphærococcus inflatipes, Maskell.—Maskell, N.Z. Trans., 1892, p. 238.

Hab. In Australia, on *Eucalyptus* sp. (Victoria).

Sphærococcus leptospermi, Maskell.—Maskell, N.Z. Trans., 1893, p. 92; ib., 1894, p. 68.

Hab. In Australia, on *Leptospermum lævigatum* (New South Wales).

Sphærococcus melaleucæ, Maskell.—Maskell, N.Z. Trans., 1893, p. 94.

Hab. In Australia, on *Melaleuca linariifolia* (New South Wales).

Sphærococcus pirogallis, Maskell.—Maskell, N.Z. Trans., 1893, p. 95.

Hab. In Australia, on *Leptospermum flavescens* (New South Wales).

Sphærococcus styphelieæ, Maskell.—Maskell, N.Z. Trans., 1894, p. 67.

Hab. In Australia, on *Styphelia (Monotoca) elliptica* (New South Wales).

Genus **Cylindrococcus**, Maskell.

This genus has been reported only from Australia.

Cylindrococcus amplior, Maskell.—Maskell, N.Z. Trans., 1891, p. 44; ib., 1892, p. 240.

Hab. In Australia, on *Casuarina quadrivalvis* (South Australia).

Cylindrococcus casuarinæ, Maskell.—Maskell, N.Z. Trans., 1891, p. 41.

Hab. In Australia, on *Casuarina quadrivalvis* (Victoria).

Cylindrococcus spiniferus, Maskell.—Maskell, N.Z. Trans., 1891, p. 43.

Hab. In Australia, on *Casuarina quadrivalvis* (Victoria; South Australia).

Genus **Aspisarcus**, Newport.

This genus has only been reported from Australia.

Aspisarcus eucalypti, Newport. — Walker, "Catalogue of Homoptera," 1852, 1088.

Hab. In Australia, on *Eucalyptus.*

Nothing more is known of this genus and species, and even the group to which it may belong is unknown. It is placed here merely provisionally, and in all likelihood it will turn out to be a *Psyllid.*

Sub-family MONOPHLEBINÆ, Signoret.

Genus **Monophlebus**, Leach.

This genus has been reported from Africa, East Indies, and Australia.

Monophlebus crawfordi, Maskell. — Maskell, Trans. Roy. Soc. South Australia, 1887–88, p. 108; N.Z. Trans., 1890, p. 28; ib., 1891, p. 51; ib., 1892, p. 243; ib., 1893, p. 102.

Hab. In Australia, on *Eucalyptus*, var. sp. (South Australia; Victoria; New South Wales; Queensland).

Monophlebus crawfordi, Maskell, var. *levis*, Maskell.—Maskell, N.Z. Trans., 1892, p. 244; ib., 1893, p. 102.

Hab. In Australia, on *Eucalyptus*, var. sp. (South Australia; Victoria; New South Wales).

Monophlebus crawfordi, Maskell, var. *pilosior*, Maskell.—Maskell, N.Z. Trans., 1892, p. 244; ib., 1893, p. 102.

Hab. In Australia, on *Eucalyptus*, var. sp. (South Australia; Victoria; New South Wales).

Monophlebus fuscus, Maskell.—Maskell, N.Z. Trans., 1892, p. 244.

Hab. In Australia, on *Eucalyptus*, var. sp. (New South Wales).

Monophlebus illigeri, Westwood.—Westwood, Arcana Ent. I., 22, 3. Signoret, Ann. de la Soc. Ent. de France, 1875, p. 365.

Hab. In Tasmania, on (?).

Genus **Callipappus**, Guérin.

This genus has only been reported from Australia.

Callipappus westwoodii, Guérin.—Guérin, Revue Zoolog., 1841, p. 129. Westwood, Introd. to Mod. Class. of Insects, 1840, p. 450.

Hab. In Australia, on (?).

Genus **Tessarobelus**, Montrouzier.

This genus has only been reported from New Caledonia.

Tessarobelus guerinii, Montrouzier.—Montrouzier, Ann. de la Soc. Linn. de Lyon, 1864, p. 246. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 600.

Hab. In New Caledonia, on *Melaleuca* sp., *Filices*, var. sp.

Genus **Leachia**, Signoret.

This genus has been reported from Europe, Brazil, and New Zealand.

Leachia zealandica, Maskell.—Maskell, N.Z. Trans., 1890, p. 26.

Hab. In New Zealand, on *Podocarpus totara*, *Fagus* var. sp., *Cupressus dacrydioides*, &c. (Reefton).

Genus **Cœlostoma**, Maskell.

This genus has only been reported from Australia and New Zealand.

Cœlostoma assimile, Maskell.—Maskell, N.Z. Trans., 1889, p. 153; ib., 1890, p. 30.

Hab. In New Zealand, on *Fagus* sp. (Reefton).

Cœlostoma australe, Maskell.—Maskell, Proc. Linn. Soc. New South Wales, 1890, p. 280; N.Z. Trans., 1892, p. 242; ib., 1894, p. 69.

Hab. In Australia, on *Angophora* sp., *Eucalyptus* sp. (New South Wales).

Cœlostoma compressum, Maskell.—Maskell, N.Z. Trans., 1891, p. 45.

Hab. In New Zealand, on *Podocarpus totara* (Reefton).

Cœlostoma immane, Maskell.—Maskell, N.Z. Trans., 1891, p. 49; ib., 1892, p. 241; ib., 1894, p. 69.

Hab. In Australia, on *Acacia aneura* (South Australia; New South Wales).

Cœlostoma pilosum, Maskell.—Maskell, N.Z. Trans., 1890, p. 29; ib., 1891, p. 49.

Hab. In New Zealand, on *Podocarpus totara*, *Fagus* var. sp., &c. (Reefton).

Cœlostoma rubiginosum, Maskell. — Maskell, N.Z. Trans., 1892, p. 242.

Hab. In Australia, on *Banksia integrifolia* (Victoria).

Cœlostoma wairoense, Maskell. — Maskell, N.Z. Trans., 1883, p. 141 ; Scale-Insects of N.Z., 1887, p. 109.

Hab. In New Zealand, on *Phormium tenax, Leptospermum scoparium* (Northern Wairoa).

Cœlostoma zealandicum, Maskell.—Maskell, N.Z. Trans., 1879, p. 294; ib., 1881, p. 226; ib., 1883, p. 141; Scale-Insects of N.Z., 1887, p. 107.

Hab. In New Zealand, on *Muhlenbeckia adspersa, Rhipogonum scandens*, and many forest-trees (passim).

Genus **Icerya**, Signoret.

This genus has been reported from Mauritius, North America, India, Australia, Egypt, New Zealand, Sandwich Islands.

Icerya ægyptiaca, Douglas.—Douglas, Ent. Mo. Mag., 1890, p. 79. Riley and Howard, "Insect Life," 1890 (November), p. 97. Maskell, N.Z. Trans., 1893, p. 99.

Hab. In Australia, on *Goodenia ovata* (New South Wales); in Egypt, on *Ficus* sp.

Icerya koebelei, Maskell. — Maskell, N.Z. Trans., 1892, p. 245; ib., 1894, p. 69.

Hab. In Australia, on *Leptospermum lævigatum* (New South Wales; Queensland).

Icerya purchasi, Maskell.—Maskell, N.Z. Trans., 1878, p. 221; ib., 1883, p. 140; ib., 1884, p. 30; ib., 1886, p. 45; Scale-Insects of N.Z., 1887, p. 104. Riley and Howard, "Insect Life" (passim).

Hab. In New Zealand, Australia, Sandwich Islands, South Pacific Islands, North America, &c., &c., on almost every plant (passim).

Icerya rosæ, Riley and Howard, var. *australis*, Maskell.—Riley and Howard, "Insect Life," November, 1890, p. 93. Maskell, N.Z. Trans., 1893, p. 101.

Hab. In Australia, on *Hakea gibbosa* (New South Wales).

Genus **Margarodes**, Guilding.

This genus has been reported from Mexico, Chili, and the West Indies. It is the "ground pearl of the Antilles."

Margarodes sp. (?), Trimen.

Hab. In Australia, underground (?) (North Australia). A doubtful insect. All that I know about it is that a specimen is in the British Museum labelled as above. But it may be of some other genus.

Sub-family BRACHYSCELINÆ.

Genus **Frenchia**, Maskell.

This genus has only been reported from Australia.

FRENCHIA CASUARINÆ, Maskell.—Maskell, N.Z. Trans., 1891, p. 57.

Hab. In Australia, on *Casuarina equisetifolia*, *Casuarina quadrivalvis* (Victoria).

FRENCHIA SEMIOCCULTA, Maskell.—Maskell, N.Z. Trans., 1894, p. 70.

Hab. In Australia, on *Casuarina* sp. (New South Wales).

Genus **Tachardia**, Signoret (1886).

Carteria, Signoret (1876).

This genus has been reported from Australia, North America, Africa, Asia.

TACHARDIA ACACIÆ, Maskell. *Carteria acaciæ*, Maskell.—Maskell, N.Z. Trans., 1891, p. 56.

Hab. In Australia, on *Acacia*, sp. (Central Australia).

TACHARDIA DECORELLA, Maskell. *Carteria decorella*, Maskell. —Maskell, N.Z. Trans., 1892, p. 247; ib., 1894, p. 70.

Hab. In Australia, on *Myrica cerifera*, *Styphelia (Monotoca) elliptica* (New South Wales).

TACHARDIA MELALEUCÆ, Maskell. *Carteria melaleucæ*, Maskell. —Maskell, N.Z. Trans., 1891, p. 54; ib., 1892, p. 249.

Hab. In Australia, on *Melaleuca uncinata*, *Melaleuca pustulata*, *Eucalyptus* sp., *Aster axillaris*, *Leptospermum lævigatum* (New South Wales; Victoria).

Genus **Brachyscelis**, Schrader.

This genus has only been reported from Australia.

BRACHYSCELIS BAUERLENI, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 359. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

BRACHYSCELIS (?) BEYERIÆ, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 276.

Hab. In Australia, on *Beyeria opaca* (South Australia).

BRACHYSCELIS CALYCINA, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 275.

Hab. In Australia, on *Eucalyptus dumosa*, *Eucalyptus oleosa* (South Australia).

Brachyscelis citricola, Schrader.—Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 3. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 597.

Hab. In Australia, on (?).

Brachyscelis conica, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 365. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus viminalis* (New South Wales; Victoria).

Brachyscelis crispa, Olliff.—Olliff, MS.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Brachyscelis duplex, Schrader.—Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 2. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 596. Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 358. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Brachyscelis ellipsoidalis, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus* sp. (Western Australia).

Brachyscelis glabra, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 278.

Hab. In Australia, on *Eucalyptus rostrata* (South Australia).

This is probably identical with *B. ovicola*, Schrader.

Brachyscelis minor, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 363. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus hæmastoma* (New South Wales).

Brachyscelis munita, Schrader.—Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 2. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 597. Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 359. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 271; ib., p. 273.

Hab. In Australia, on *Eucalyptus robusta*, *Eucalyptus* var. sp. (New South Wales; Victoria; South Australia).

Brachyscelis (?) neumanni, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 275.

Hab. In Australia, on *Eucalyptus dumosa* (South Australia).

Brachyscelis nux, Olliff.—Olliff, MS.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Brachyscelis ovicola, Schrader.—Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 3. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 596. Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 367. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus hæmastoma*, *Eucalyptus gracilis*, *Eucalyptus leucoxylon* (New South Wales; Victoria).

Brachyscelis ovicoloides, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 277.

Hab. In Australia, on *Eucalyptus incrassata*, *Eucalyptus odorata* (South Australia).

Brachyscelis pharetrata, Schrader. — Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 3. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 595. Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 370.

Hab. In Australia, on *Eucalyptus sieberiana*, *Eucalyptus corymbosa*, *Eucalyptus capitellata* (New South Wales).

Brachyscelis pileata, Schrader. — Schrader, Trans. Ent. Soc., New South Wales, 1862, p. 3. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 593. Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 362. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus hæmastoma*, *Eucalyptus piperita*, *Eucalyptus sieberiana*, *Eucalyptus capitellata* (New South Wales).

Brachyscelis pomiformis, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 367. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus* sp. (Queensland; Western Australia).

Brachyscelis regularis, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 273.

Hab. In Australia, on *Eucalyptus rostrata* (South Australia).

Brachyscelis rugosa, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 369. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Brachyscelis (?) strombylosa, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 277.

Hab. In Australia, on *Eucalyptus incrassata* (South Australia).

Probably not a *Brachyscelis*.

Brachyscelis subconica, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 274.

Hab. In Australia, on *Eucalyptus uncinata* (South Australia).

Brachyscelis thorntoni, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 371. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Brachyscelis tricornis, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 361.

Hab. In Australia, on *Eucalyptus siderophloia* (New South Wales).

Brachyscelis umbellata, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 336.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Brachyscelis urnalis, Tepper.—Tepper, Trans. Roy. Soc. South Australia, 1893, p. 274.

Hab. In Australia, on *Eucalyptus uncinata* (?), *Eucalyptus gracilis* (?) (South Australia).

Brachyscelis variabilis, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1892, p. 364. Tepper, Trans. Roy. Soc. South Australia, 1893, p. 272.

Hab. In Australia, on *Eucalyptus piperita*, *Eucalyptus* var. sp. (New South Wales).

Genus **Opisthoscelis**, Schrader.

This genus has been reported only from Australia.

Opisthoscelis fibularis, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 344.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales; Victoria).

Opisthoscelis gracilis, Schrader.—Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 10. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 598.

Hab. In Australia, on (?) (New South Wales).

Opisthoscelis maculata, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 345.

Hab. In Australia, on *Eucalyptus leucoxylon*, *Eucalyptus gracilis* (Victoria).

Opisthoscelis mammularis, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 344.

Hab. In Australia, on *Eucalyptus*, sp. (Victoria).

OPISTHOSCELIS MASKELLI, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 340.

Hab. In Australia, on *Eucalyptus siderophloia, Eucalyptus* var. sp. (New South Wales).

OPISTHOSCELIS PISIFORMIS, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 343.

Hab. In Australia, on *Eucalyptus melliodora, Eucalyptus robusta, Eucalyptus piperita, Eucalyptus resinifera* (New South Wales).

OPISTHOSCELIS SERRATA, Froggatt. — Froggatt, Proc. Linn. Soc., New South Wales, 1893, p. 346.

Hab. In Australia, on *Eucalyptus* sp. (Victoria).

OPISTHOSCELIS SPINOSA, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 341.

Hab. In Australia, on *Eucalyptus siderophloia* (New South Wales).

OPISTHOSCELIS SUBROTUNDA, Schrader. — Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 10. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 597. Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 210.

Hab. In Australia, on *Eucalyptus capitellata* (New South Wales).

OPISTHOSCELIS VERRUCULA, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 338.

Hab. In Australia, on *Eucalyptus* sp. (New South Wales).

Genus **Ascelis**, Schrader.

This genus has been reported only from Australia.

ASCELIS ATTENUATA, Froggatt.—Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 214.

Hab. In Australia, on *Eucalyptus piperita* (New South Wales).

ASCELIS PRÆMOLLIS, Schrader.—Schrader, Trans. Ent. Soc. New South Wales, 1862, p. 10. Signoret, Ann. de la Soc. Ent. de France, 1876, p. 599. Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 211.

Hab. In Australia, on *Eucalyptus corymbosa* (New South Wales).

ASCELIS SCHRADERI, Froggatt. — Froggatt, Proc. Linn. Soc. New South Wales, 1893, p. 213.

Hab. In Australia, on *Eucalyptus corymbosa* (New South Wales).

ART. II.—*Further Coccid Notes: with Description of New Species from New Zealand, Australia, Sandwich Islands, and elsewhere, and Remarks upon many Species already reported.*

By W. M. MASKELL, Registrar of the New Zealand University, Corr. Mem. Roy. Soc. of South Australia.

[*Read before the Wellington Philosophical Society, 14th November, 1894.*]

Plates I.–VII.

I FIND it necessary to make some remarks concerning the principle upon which I have acted for several years with regard to the erection of new species, the comparison of varieties, or the identification of species already known; because, in the course of correspondence with different other students of Coccids, as well as in their published writings, it seems that they accept canons of procedure which do not recommend themselves to me as sufficient. In the first place, I may say that the bent of my inclination is towards the restriction of the number of species rather than towards their extension. Looking upon classification as a means to an end, I consider that the very first, and probably only, requisites for it are clearness and convenience. For this reason, neither the fancied claims of priority, nor the desire to uphold some preconceived theory, nor even the wish to be the publisher to the world of some new thing, ought to weigh with us at all. Personally, I disclaim any position but that which some people nowadays affect to despise—the position of a classifier, the laying-down of a stratum of facts upon which, some day, when we really do reach the stage of being able to say we know something, theories and doctrines may be built up. Therefore my aim is first at clearness and convenience; and with this object a careful avoidance of needless subdivision seems necessary. It is better, when a specimen is observed, to see how closely it approaches to some known form than to search for points upon which it may be separated—better to look upon a few distinguishable features, if possible, as only variable characters (making the specimen a "variety") than to cumber science with a new "species" as if these features were of real organic importance. I know, and every student of Coccids knows, that external appearance of an insect may alter frequently, from being cramped for room or from having much free space: therefore I would lay small stress upon mere *size*. Take the genus *Lecanium:* there are a number of so-called species which have been set up by different authors almost, if not quite, entirely on account of their varying size: climate,

food-plant, conditions of life, are in this case ignored. Again, we all know how deceptive a thing colour is: what is green to one man may be blue or red to another. Ornithologists and lepidopterists have invented thousands of new "species" on account of some different colour in a feather or in a wing-spot. But many cases are known in Coccid study where, even on the same twig, amongst perhaps a hundred individuals, five different "species" could be so made because there may be five variations in colour. Again, in the case of climate and food-plant: if we were to imagine that an insect in a tropical country on, say, a palm, must necessarily be for that reason a different species from one in a temperate country on a *Fagus*, it would be the simplest thing in the world to bring up the number of Coccid species to that of the Hymenoptera, ransacking every dictionary in every language to find names for them. A friend of mine once wrote that he could not agree to make two *Planchoniæ* identical "because they lived on such widely-separated orders of plants as *Coronilla* and *Bambusa*." But there are dozens of Coccids which are multivorous if not omnivorous: for example—*Aspidiotus nerii*, *A. aurantii*, *Mytilaspis pomorum*, *Ctenochiton viridis*, *Lecanium hesperidum*, *Planchonia fimbriata*, several *Dactylopii*, *Icerya purchasi*, &c. You cannot predicate that an insect living on one plant will not live equally well on another, or in another locality. Taking, therefore, these four points—size, colour, locality or climate, and food-plant—I would very seriously deprecate the notion that any of them (I will go so far as to say that all of them) should be sufficient to induce the erection of a new species. Convenience demands that they should be all mentioned in a description, as a guide to other students or as information to the public, so that anybody could know where at least to search for particular insects. Beyond that I look on them as of little or no value.

The following pages contain notes concerning many species already reported from various parts of the world, and also descriptions of more than twenty insects which, after full consideration, seem to be new. Some, such as the Australian form of *Eriococcus buxi*, or the Sandwich Island form of *Chionaspis biclavis*, I have set down as merely varieties of the original types. The others, although seeming to be quite distinct, do not present such extraordinary and interesting features as those reported in my former papers. But the discovery in Australia of representatives of the genus *Ctenochiton* (hitherto confined to New Zealand) seems to be not entirely unimportant in its bearing on the distribution of animal forms and the connection between the two countries.

With regard to *Ceronema*, the new genus which I am here proposing to establish, it may be remarked that, whilst the

secretion of all Coccids appears to be chemically the same, yet it is sometimes convenient to employ for separation the solidity or the loose texture of the resulting covering. The "wax" of *Ceroplastes*, the cotton of *Dactylopius*, and the fibrous (as it seems at first sight) puparium of *Mytilaspis*, can all, when microscopically examined, be found to be really similar in their essential character. Still, it is convenient to distinguish (for example) *Lichtensia* from *Pulvinaria*, or *Ctenochiton* from *Inglisia*, to some extent by the form, position, or structure of the secretion. I say "to some extent" because if possible the main distinction of a genus or a species ought to rest upon an organic character of the insect itself rather than upon its external covering. *Ceronema* differs from *Ceroplastes* and *Ctenochiton* in the loose texture of the test, and from the latter also in the absence of a fringe; but the secreting pores of the insect itself (in the species known so far) also differ from those of any other Lecaniodiaspid.

The species herein named *Prosopophora prosopidis* is close enough to *P. dendrobii* Douglas to be perhaps hereafter considered as only a variety; but for reasons given in its description I leave it for the present as distinct.

It appears from the synoptical list published in this volume that I am responsible for more than two hundred new species and varieties of Coccids reported from Australasia and the Pacific, besides a large number originally named by other writers and mentioned in my papers. I am sure that future years will produce a very much longer list, for the study of these insects is even yet only in its infancy; but there will be, I hope, no need for any one to make any important or subversive corrections in the work which has been so far accomplished.

Sub-family DIASPIDINÆ.

Genus Aspidiotus.

Aspidiotus cladii, Maskell. N.Z. Trans., vol. xxiii., 1890, p. 3; vol. xxv., 1892, p. 205; vol. xxvi., 1893, p. 67.

The first specimens of this species which have come to me from New South Wales have been sent by Mr. Froggatt, on a sedge, *Xerotes* sp., from Manly, near Sydney. I see no difference between them and the type. The species would thus appear to be found in all parts of Australia.

Aspidiotus longispina, Morgan. Ent. Mo. Mag., Aug., 1889, p. 352.

I have received specimens which, although there are slight differences in the puparium, I cannot separate from Mr. Morgan's species, on "China orange," mango, and other plants in the Sandwich Islands, sent by Mr. Koebele. The charac-

teristic long hairs of the abdominal extremity, partly simple and partly serrated, and the single pair of lobes, are so clear that the identity is manifest. I think, however, that there are six of the long simple hairs on each side, and not four as given by Mr. Morgan.

A minute, bright-red mite (seemingly Gamasid) was very active and numerous amongst these Sandwich Island specimens; and I found many of the *Aspidioti* which appeared to have been partly devoured, whether by this or some other parasite I could not determine.

Aspidiotus camelliæ, Boisduval. *A. rapax*, Comstock.

This insect is still very prevalent in New Zealand on many plants. It has lately attacked *Diosma* in the gardens near Wellington. I have also had specimens sent to me by Mr. Froggatt, from Sydney, on *Melaleuca nodosa*, and by Mr. French, from Melbourne, on *Rhododendron*. The species seems to be omnivorous, and bids fair to be cosmopolitan.

Aspidiotus ficûs (Riley), Comstock. Comstock, Ent. Rep. U.S. Agric. Dept., 1880, p. 296.

This species, which in North America appears to be an injurious pest on orange-trees, has been sent to me during the last year from New South Wales (by Mr. Froggatt) and from Queensland (by Mr. Koebele). The characters by which *A. subrubescens* mihi (1891) differs from it will be found in vol. xxiv. of our Transactions, p. 9. The Australian plants on which my specimens of *A. ficûs* came were not named by the senders; but I imagine them to be various kinds of *Citrus*.

Aspidiotus ceratus, sp. nov. Plate I., fig. 1.

Female puparium snowy-white, circular, convex; diameter about $\frac{1}{12}$in. when separate; but numbers of puparia are usually so massed together that measurement is difficult. Texture solid and waxy; the two pellicles are central and of a faint yellow tinge, covered by a scale of white wax.

Male puparium white, smaller, and more elongated than that of the female.

Adult female orange-coloured, pegtop-shaped; length about $\frac{1}{30}$in. Abdomen ending in two adjacent lobes with rounded emarginate ends; above them are two club-shaped organs. The abdominal margin is serratulate and bears some short spines: of these spines, one on each side, not far from the lobes, is widely forked. No groups of spinnerets.

Adult male unknown.

Hab. In Australia, on *Acacia stenophylla*. Mr. French sent me specimens from the banks of the Murray River, in South Australia.

This species may be distinguished by the white waxy puparia, and by the large forked spines on the abdominal margin.

Aspidiotus vitiensis, sp. nov. Plate I., fig. 2.

Female puparium greyish-white as a rule, but varying somewhat in colour according to the bark of the tree; form probably nearly circular, but so many are usually massed together that it is difficult to make out the outline; slightly convex. Diameter probably about $\frac{1}{25}$in. Pellicles subcentral, yellow.

Male puparium similar in colour to that of the female, but smaller and more elliptical. Length about $\frac{1}{40}$in.

Adult female brown, pegtop-shaped: length about $\frac{1}{16}$in. Abdomen ending in two large median triangular lobes with serrated sides, not adjoining: on each side is a small cylindrical lobe, followed by a forked spine, and, after an interval, two smaller conical lobes and another forked spine: the abdominal margin bears also a few other spines. Four groups of spinnerets: upper groups 6–10 orifices, lower groups about 15.

Hab. In Fiji, on "several different forest-trees." My specimens were sent by Mr. Koebele.

Aspidiotus unilobis, sp. nov. Plate I., fig. 3.

Female puparium really whitish, but generally covered by so much dense black fungus that it seems black, and is very difficult to distinguish. Form circular, slightly convex; pellicles orange, central, forming a minute boss. Diameter about $\frac{1}{20}$in.

Male puparium white, elongated, not carinated. Length about $\frac{1}{25}$in.

Adult female dark-orange, pegtop-shaped; length about $\frac{1}{30}$in. Abdomen ending in one single median dome-shaped lobe, on each side of which are a few fine hairs. No groups of spinnerets. The margin of the abdomen is finely striated and minutely crenulated.

Adult male unknown.

Hab. In Australia, on *Acacia* sp. (tea-tree), Mount Victoria, New South Wales.

The single median lobe sufficiently distinguishes this species. A similar character is seen in *Chionaspis quercûs,* Comstock.

Aspidiotus aurantii, Maskell.

I am constantly receiving specimens of this insect from many widely-separated localities, and on many different trees. It is not at all confined to the orange, and is, seemingly, ubiquitous in warm temperate countries. The colour varies a little, and lately I have had some from Honolulu, on a species

of *Podocarpus* from Japan, which are of a good deal deeper red than the type.

In the United States "Agricultural Bulletin," No. 23, 1891, Mr. Coquillett mentions, under the name of "the yellow scale, *Aspidiotus citrinus*," a form which, from careful examination of specimens sent to me by Mr. Ehrhorn, of Santa Clara County, California, I find are clearly only *A. aurantii*. Mr. Ehrhorn informs me that he and Professor Comstock and several others have come to the same conclusion. I am sorry that a distinction founded on so slight a character as mere colour should be so often suggested. No scientific description of this form has yet appeared, that I know of.

Aspidiotus extensus, sp. nov. Plate I., figs. 4, 5.

Female puparium of a dull dirty-yellow or brown colour, frequently obscured by black fungus, subcircular, convex, and usually somewhat conical; diameter, about $\frac{1}{12}$in. at full development. The larval pellicle is black, situated at the apex of the cone; the second pellicle is very inconspicuous, and it is difficult to make out its dimensions, but close examination shows that it occupies about half the puparium. The surface of the puparium is finely striated.

Male puparium subcircular, of a grey or bluish-grey colour, rather convex, but less so than that of the female. The pellicle is less black than in the female, and is not placed centrally. Diameter of puparium about $\frac{1}{20}$in.

In all the specimens seen the female puparia were on the twigs, the male puparia on the leaves.

Adult female dark-brown, pegtop-shaped, with a distinct prolongation of the abdominal region, by which the abdominal margin is slightly concave. The size varies: specimens seen range in length from $\frac{1}{30}$in. to $\frac{1}{14}$in. The prolongation of the abdomen bears two median lobes, set so closely together as to look like one, their outer margins sloping, and minutely serratulate; beyond these the abdominal margin is irregular, and bears some rather strong spines and cylindrical processes blunt at the tips, and there is a longish spiny hair at the innermost point of the concavity of the margin. There are no groups of spinnerets.

Adult male dark-brown; form rather stout and thick; length (exclusive of spike) about $\frac{1}{35}$in.; the spike is about as long as the abdomen. Antennæ and feet normal. There seem to be two dorsal eyes, two ventral, and two ocelli; but my specimens are not clear as to these.

Hab. In Australia, on *Eucalyptus capitellata*. My specimens were sent by Mr. Froggatt, from Bankstown, near Sydney; and I have also two, which seem to be quite similar, on the same plant from Victoria, sent by Mr. French.

I was for a long time in doubt whether this very distinct species ought not to belong rather to the genus *Aonidia* than to *Aspidiotus*, because I could not detect the limits of the second pellicle in the female puparium. The inside of the puparium is quite dark-coloured, and if the pellicle extended to, or nearly to, the margin it would be much larger than the adult female, and would thus indicate *Aonidia*. I believe, however, that it is rightly placed in *Aspidiotus*. The concavity of the abdomen is a feature noticeable also in *A. articulatus*, Morgan ; but in that species there are several terminal lobes, and also a clear groove separating the thoracic from the abdominal region. The concavity in *A. extensus* is, in fact, so near to the posterior extremity that there seems to be almost a "tail."

The separation of the male from the female puparia (the former on the leaves, the latter on the twigs) is not a very common occurrence among Coccids, but it is fairly frequent. I have mentioned it myself in *Fiorinia asteliæ*, *Lecanium baccatum*, &c., and Mr. Newstead has observed it in *Aspidiotus zonatus* (Ent. Mo. Mag., Dec., 1893, p. 279) and others. I have some twigs of *Acacia linifolia*, from Hornsby, New South Wales, on which are great numbers of puparia, seemingly all males of some Diaspid, but I cannot detect any females amongst them.

Aspidiotus extensus seems to be certainly a distinct and new species.

Genus Aonidia, Targioni-Tozzetti.

Signoret (Ann. de la Soc. Entom. de France, March, 1868) states that this genus was established by Targioni to suit a species which had till then been known as "*Coccus aonidum*," Linn. The characters distinguishing it are—1st, "two shields superimposed" (I confess that I do not understand the meaning of this phrase); 2nd, "a larval pellicle occupying the centre of the puparium, and a second pellicle occupying the whole of it." If, by two superimposed shields, Targioni means that the larval pellicle overlies the second, then there is nothing in that to distinguish it from *Aspidiotus;* but the other character, of an abnormally large second pellicle, is a valid one, and, as I remarked in vol. xxiv. of our Transactions, 1891, p. 13, it places *Aonidia* in a similar relation to the other genera with round puparia to that which is occupied by *Fiorinia* in relation to those with elongated puparia.

It would appear from Signoret that, although the insect *Coccus aonidum* has given a base for the genus *Aonidia*, yet there is much doubt as to what it really was. Linnæus himself in his description compares it with *Lecanium hesperidum*, and Olivier (1791) repeats this, and says that it resembles "the

scale of the orange" (which I take to mean also *L. hesperidum*); but Targioni refers the insect to *Aspidiotus lauri*, Bouché, which he first renamed *Aonidia purpurea*, and afterwards *Aonidia lauri*. However, in spite of this confusion and uncertainty, I think that it is quite convenient to accept the genus *Aonidia* on the main, and indeed sole, ground of the comparative size of the second pellicle.

No species of the genus has, I think, been described from 1868 till now; but Mr. Green has an insect in Ceylon which clearly belongs to it, and which he proposes to name *Aonidia corniger;* and I attach to the genus the Australian species which I am now about to describe.

Aonidia fusca, sp. nov. Plate I., figs. 6–9.

Female puparium regularly circular, very dark-brown or dull-black; slightly convex; diameter about $\frac{1}{35}$in. The larval pellicle is very small, central: the second pellicle occupies nearly all the puparium, but is not to be made out until the puparium is overturned; it is larger than the adult female, and also more elongated. Dorsally the whole puparium appears black; but when overturned the second pellicle is seen to be yellow, being covered with a coating of black secretion. The margin of the puparium extends only a small distance beyond the pellicle all round; the pellicle has thus a length of about $\frac{1}{40}$in.

Male puparium, dirty yellowish-grey, irregularly elliptical, the pellicle situated near one end; slightly convex. Length about $\frac{1}{30}$in., being thus larger than that of the female.

Adult female regularly pegtop-shaped, orange-yellow; length about $\frac{1}{65}$in., being therefore much smaller than the second pellicle. Abdomen ending in four lobes, of which the two median are the largest, and are rounded, with a small indentation on the outer margin; they are closely adjacent, and are separated from the two smaller lobes by a narrow rounded incision of the margin. Beyond the lobes are a few short fine hairs. There are no groups of spinnerets, but many small circular scattered single ones.

Adult male unknown. I possess a mounted specimen of a pupa in the puparium, presenting no special features.

Hab. In Australia, on peach (*Persica vulgaris*). Mr. French sent me the specimens, stating that they came from the garden of Mr. Benson, Bulga, New South Wales. I cannot discover any description of a Diaspid attacking peach-trees in Europe or America which answers to this insect. It is not *Aspidiotus niger*, Signoret; and for the present I must consider that it has migrated to Mr. Benson's fruit-trees from some native plants in the vicinity. In "Insect Life," May, 1894, there is a description of *Diaspis lanata*, Morgan and

Cockerell, found on peach-trees in America, and a new importation there. [For reasons unknown to me, the specific name of this insect is given by both Mr. Cockerell and "Insect Life" as "*lanatus*"; but *Diaspis* is surely feminine.] This is entirely different from *Aonidia fusca*; the form of the male puparium and the spinneret-groups of the female are sufficient distinctions.

Genus Diaspis, Costa.

Diaspis pinnulifera, Maskell. N.Z. Trans., 1890, p. 4; 1892, p. 208.

In the "Canadian Entomologist," 1894, p. 127, Mr. T. D. Cockerell observes that the "female of *D. pinnulifera* presents an extraordinary resemblance to *Aspidiotus dictyospermi*, Morgan (Ent. Mo. Mag., August, 1889, p. 352), but the form of the male scale will at once separate it from any *Aspidiotus*."

The only three references to *A. dictyospermi* which I can find are those of Mr. Morgan and Mr. Cockerell just mentioned, and one by Mr. Newstead (Ent. Mo. Mag., August, 1893, p. 185). The two first make no definite mention of the male scale; but the last says, "Scale of the male of the same colour and has the same structure at apex as the female." It is presumable therefore that in *A. dictyospermi* the male puparium is "greyish-white" (Morgan), or "reddish or orange-brown" (Cockerell). But that of *D. pinnulifera* is quite clearly pure-white, and it is not at all like an *Aspidiotus* male, being cylindrical and carinated as in *Diaspis rosæ*, or even as in many species of *Chionaspis*. (See also *D. amygdali*, below.)

According to Mr. Morgan, the two "long plates" on each side of the female abdomen are "serrated" in *A. dictyospermi*. I cannot detect any serrations in the "feathery processes" of *D. pinnulifera*.

Diaspis boisduvalii, Signoret.

Occurs at Adelaide, on hothouse orchids (*Cattleya* and *Dendrobium*). My specimens are from Mr. J. Quinn, Secretary to the South Australian Gardeners' Society. I have already reported it on similar plants in New Zealand; and Mr. Koebele has sent me a leaf of orchid from Honolulu infested rather badly by this insect.

Diaspis amygdali, Tryon. *Diaspis lanata*, Morgan and Cockerell.

I have received from Mr. Koebele a twig of peach-tree from Sydney, and another of the same tree from Brisbane, on both of which are a number of insects, which are certainly of the genus Diaspis; and close examination shows that they are

identical with *D. amygdali*, Tryon ("Report on Insect and Fungus Pests, Queensland," 1889, p. 89). I have very carefully compared these specimens with those of *D. lanata* which were sent to me several months ago by Mr. Cockerell, and with the description and figures of the same insect given in "Insect Life," May, 1894. As the result, I am able to say that in all essential or important characters the two are identical. I have not been able to distinguish the two dorsal "distinct impressed subdorsal lines" mentioned in "Insect Life," nor am I quite clear as to the meaning of the term; and in some of my Australian specimens, though not in all, the median terminal lobes are not as distinctly incised on their margins as in the figure (No. 14) on page 292 of the same work. On the other hand, there are rather more orifices, sometimes, in the two posterior lateral spinneret-groups than in those described by either author; for two specimens observed show thirty-eight orifices in these groups. There is a character mentioned in the descriptions of *D. lanata*—"scale covered with a thin layer of the outer skin of the bark"—which is clearly visible in my Australian specimens, although it is not there as conspicuous as on my specimens of *D. lanata*, probably because these are on *Capsicum*, which seems to have a thicker skin than *Peach*: however, there is no difficulty in recognising it. All the differences which I have just mentioned are of very slight, indeed of no, importance. The male puparium is quite identical.

Mr. Tryon published his report, including a description of *D. amygdali*, in 1889. The description of *D. lanata* appeared in 1892 (I have already remarked, *ante*, on the error of gender in the specific name). The latter must consequently give way to the former.

The common peach is not a native of Australia, and *D. amygdali*, which seems not to occur in that country on any other plant, must be an importation from elsewhere. The authors of "Insect Life" think that it is a West Indian species, and that it has spread from the islands to California, Georgia, and as far north as Washington. If one might judge from the ordinary courses of communication, the insect would seem to have come to Australia either from California or else, *viâ* Panama, from Jamaica, where it is found upon a great variety of plants. I have not yet heard of it on peaches in New Zealand.

Genus Mytilaspis.

Mytilaspis casuarinæ, Maskell. N.Z. Trans., vol. xxv., 1892, p. 209.

Specimens of this insect on *Casuarina* with very slender twigs (*C. equisetifolia*?) have much narrower puparia than those on

larger twigs; as indeed is usual in many cases. The size of Coccids is subject to much variation according to the food-plant, and cannot be considered as being a character of any importance.

Mytilaspis nivea, sp. nov. Plate I., fig. 10.

Female puparium elongated, usually straight, narrow, snowy-white. Pellicles terminal, yellow. The length may be about $\frac{1}{20}$in.; but the puparia are usually so massed together, forming a snowy heap on the twig, that it is not easy to make them out separately.

Male puparium similar to that of the female, but smaller. Length about $\frac{1}{30}$in. Not carinated.

Adult female brown. Form normal. Abdomen ending with a small median depression, at each side of which is a pointed triangular lobe, and after an interval another similar lobe of the same size. Abdominal margin deeply serrated, and bearing at each side three or four rather strong spines. The groups of spinnerets are five: upper group with 3 or 4 orifices; upper laterals, 10 to 12; lower laterals, 16 to 24.

Adult male yellow; length about $\frac{1}{40}$in. There are no characters specially distinguishing it from others of the genus.

Hab. In Australia, on *Melaleuca nodosa*. Specimens from Mr. Froggatt, from Bankstown, near Sydney.

A species by no means far removed from *M. casuarinæ*, Mask. (1892), but differing principally in the four conical lobes and in the stronger marginal spines. The puparia look exactly like snow on the twigs.

Mytilaspis pallida, Green (var.?).

I have received from Mr. Koebele a *Mytilaspis* on *Podocarpus* sp., imported into Honolulu from Japan, which seems to me to be so close to a species in Ceylon to which Mr. Green proposes to give the name of *M. pallida* that I believe it to be identical. Mr. Green has not yet published a description of his insect. It is possible that it, and mine, may in the end turn out to be varieties of *M. citricola*, Packard, an insect which I find to infest not only *Citrus* but many other plants in warm countries. The puparium of *M. pallida* resembles much that of *M. citricola*, with a rather paler colour; the lobes and spines of the abdominal extremity are also nearly similar, but smaller and finer. I am not clear about the spinneret-groups, and the abdominal extremity seems more truncate than in *M. citricola*. But in any case the Cingalese and the Japanese forms appear to be very closely allied.

Mytilaspis flava, Targioni-Tozzetti, var. **hawaiiensis**, var. nov.

Female puparium really yellowish, but covered with a greyish-white secretion which makes it look grey and like the bark of the tree. Form mussel-shaped; length about $\frac{1}{20}$in.; slightly curved; generally massed together in numbers.

Male puparium similar, but smaller and straighter. Length about $\frac{1}{40}$in.

Adult female yellow, of normal elongate form, the segments usually distinct. Abdomen ending in two large median lobes, which are widely triangular, the outer edges minutely serrulate. Just above them are two club-shaped organs extending a little way within the body. At each side of the lobes are a few spines. Five groups of spinnerets: upper group with 3 orifices; upper laterals with 6; lower laterals, 4 to 6. The abdominal segments anterior to the pygidium seem to bear no spines.

Adult male unknown.

Hab. In the Sandwich Islands, on "bark of trees" at Kauai; plant-names not given. My specimens are from Mr. Koebele.

I can see nothing separating this from the European species (infesting *Olea europæa*) excepting the absence of spines from the anterior abdominal segments, and as to that I am not entirely positive. The club-shaped organs mentioned resemble those of *Chionaspis biclavis*, Comstock.

Mytilaspis striata, sp. nov. Plate I., figs. 11, 12.

Female puparium elongated, mussel-shaped, rather convex; length, about $\frac{1}{25}$in. The secreted portion exhibits many transverse bands of silvery-white colour, separated by narrower bands of dark-grey. Pellicles orange.

Male puparium of similar form, and with similar bands, not carinated. Length, about $\frac{1}{40}$in.

Adult female orange-coloured, darkening with age to brown. Form normal of the genus; the segments not prominent, but exhibiting faint striations which seem to correspond with those of the puparium. Abdomen ending in a semicircular curve broken by small serrations, with four sharply-pointed small triangular lobes rather widely separated. No groups of spinnerets; but a row of oval pores runs round the margin of the abdominal and thoracic regions, and on the abdominal dorsum there are a number of small circular single spinnerets.

Adult male unknown.

Hab. In Australia, on *Casuarina* sp. (very slender twigs). Mr. Froggatt sent me specimens from Sydney.

This species, in the absence of spinneret-groups, ap-

proaches *M. convexa*, Mask., 1893 (on *Acacia*); but the four terminal triangular lobes distinguish it. The transverse bands of the puparium would not, I think, by themselves denote more than a variety.

Mytilaspis lactea, sp. nov. Plate II., figs. 1, 2.

Female puparium of a delicate white colour, but frequently more or less covered by a very thin layer of bark-cells of the plant. Pellicles pale yellow. The puparium is broadly pyriform; length, about $\frac{1}{8}$in.

Male puparium snowy-white, semicylindrical; length, about $\frac{1}{25}$in.; not at all carinated.

Adult female dull-pink in colour, darkening to brown at gestation. Form elongated, segmented; length about $\frac{1}{16}$in. Abdomen ending with a small median depression, the sides of which form two lobes with rounded ends, which are minutely serrulated: separated from these by a spine, on each side, is a smaller rounded lobe followed by a spine, and, after a small interval, two other much smaller lobes. The margin beyond these lobes is irregular, and bears a few spines. Each segment of the body has also a few marginal spines. There are five groups of spinnerets: upper group with 6 to 8 orifices; upper laterals, 20 to 25; lower laterals, 25 to 35. There are also, on each side of the groups, three rows of large oval pores.

Adult male unknown.

Hab. In New Zealand, on bark of *Fuchsia excorticata*. My specimens were mostly collected in the neighbourhood of Wellington, but I have a few from Woodville.

Those who classify species according to colour would probably attach this insect to *Chionaspis*. But the absence of any trace of a keel on the male puparium is much more important, and according to my regular plan I place it in *Mytilaspis*. In the inclusion of bark-cells amongst the secretion of the female puparium it approaches *M. leptospermi*, Mask. (1881); but the characters of the abdomen separate it from that, and, I think, from all other, species: more especially the terminal median depression.

Mytilaspis citricola, Packard.

I have received specimens of this species from Mr. Quinn, on *Croton* sp. from a hothouse at Adelaide. No mention is made in his letter of any orange or other *Citrus* trees growing in the house, and it is stated indeed that the insect is "very destructive, and seems confined to *Croton* chiefly." Specimens have also been sent to me on *Banksia integrifolia* from Melbourne, by Mr. French. These last are intelligible enough, as they might easily have spread from orange-trees; but I am not so

clear about the Adelaide *Crotons:* yet of course there might be *Citrus* trees in the vicinity.

Genus CHIONASPIS.

Chionaspis prunicola, sp. nov. Plate II., figs. 3–5.

Female puparium whitish, very broadly pyriform, the margin widening so directly from the first pellicle that the whole seems almost elliptical or even subcircular. Length about $\frac{1}{20}$in. The white secretion seems to be easily rubbed off, and the yellow or yellowish-brown pellicles are exposed. The first pellicle is rather small, terminal; the second appears to occupy about half the puparium. The insects are frequently so massed together on the plant that it is very difficult to make out the exact form.

Male puparium white, the pellicle yellow; form elongated, with parallel sides; length, about $\frac{1}{30}$in. The secreted portion is carinated, but the single median carina is by no means conspicuous, and may be easily overlooked.

Adult female yellow or yellowish-brown, very little elongated; the cephalic and thoracic regions large in comparison with the abdominal, which tapers rapidly. Abdomen terminating in two median lobes, which are triangular with broad bases and crenated sides: on each side of these is a small cylindrical lobe with rounded end, followed by a short spine; then an interval followed by two small triangular lobes: the margin of the abdomen is serrated. Five groups of spinnerets: upper group, 14–20 orifices; upper laterals, 28–34; lower laterals, 20–26. There are three or four rows of large oval pores on each side, marking the abdominal segments.

Adult, male unknown.

Hab. In the Sandwich Islands, on "Japanese plum": specimens sent by Mr. Koebele, who informs me that the plants have been destroyed by the insects. I presume therefore that the insect comes originally from Japan.

It is difficult to make out the real form of the female puparium in this species, which very frequently approaches that of a *Diaspis*, in its elliptical or subcircular outline. But the form of the adult female agrees much better with *Chionaspis;* and I think there is no known species of *Diaspis* exhibiting rows of large oval pores. On the whole, I shall leave it as a *Chionaspis*. In some of its characters it seems to approach closely to *Ch. lintneri,* Comstock (2nd Cornell Univ. Report, 1883, p. 103).

Chionaspis biclavis, Comstock, var. **detecta,** var. nov.

Female puparium greyish-white, somewhat solid, broadly pyriform or subelliptical; pellicles inconspicuous; length about $\frac{1}{10}$in.

Male puparium unknown.

Adult female dark-brown, of normal elongated form; length, about $\frac{1}{13}$in. Abdomen terminating, as in the type, with two largish median lobes, above which are two club-shaped organs; no groups of spinnerets; several strong marginal spines, which are also on the anterior abdominal segments.

Male unknown.

Hab. In Sandwich Islands, on "bark of shade-trees," not named, at Kona. My specimens are from Mr. Koebele.

The difference between this and Comstock's American species (in conservatories at Washington) seems to consist only in the fact that the Sandwich Island form does not burrow, but lies exposed on the bark. The anatomical characters seem identical.

Chionaspis dysoxyli, Maskell. N.Z. Trans., vol. xvii., 1884, p. 22.

This insect occurs on *Hoheria angustifolia* on the hills above the Town of Lyttelton, in this country. I found many specimens there in the autumn of this year, when searching for *Eriococcus hoheriæ*, which I failed to find. The puparia of the *Chionaspis* are narrower than those of the original type, as indeed is only natural, being on narrow twigs and leaves instead of on the broad ones of *Dysoxylon;* but I can detect no difference in the insect itself. These are the first specimens of the species reported from the Middle Island.

Chionaspis xerotidis, sp. nov. Plate II., figs. 6, 7.

Female puparium whitish, flattish, pyriform; length about $\frac{1}{8}$in. Pellicles yellow, comparatively small. The form of the puparium is frequently obscured by masses of dirt and mud.

Male puparium whitish, elongated, narrow, carinated. Length about $\frac{1}{20}$in.

Adult female yellow, elongated; length about $\frac{1}{14}$in. The abdomen ends with a small median depression, the sides of which form small lobes, and at each side there are four equally small rounded lobes with three spines, and one spine a short distance along the margin. All the abdominal and thoracic segments bear marginal groups of rather strong spines. Five groups of spinnerets: upper group with 8–10 orifices; upper laterals about 20; lower laterals about 33: but it is not easy to separate the lateral groups, and the whole arrangement is very nearly an arch. There are a great many large oval pores marking the abdominal segments.

Adult male unknown.

Hab. In Australia, on an aquatic plant of the sedge family —*Xerotes longifolia.* My specimens were sent by Mr. Frog-

gatt, from Sydney. I think that the only Coccids hitherto reported upon water-plants are *Chionaspis spartinæ*, Comstock (2nd Cornell Univ. Rep., 1883, p. 106), which differs considerably from ours, *Coccus* (?) *zosteræ*, Fabr. (Signoret, Essai, p. 467), and *Dactylopius nipæ*, Mask. (1892). There are also a few which live on plants exposed to spray on the sea-beach, such as *Ctenochiton rhizophoræ* of the present paper, or *Lecanium maritimum*, Green (MS.), in Ceylon.

Genus FIORINIA.

Fiorinia stricta, Maskell. N.Z. Trans., vol. xvi., 1883, p. 124.

This insect occurs plentifully, in company with *Chionaspis dysoxyli*, on the hills above Lyttelton, on *Hoheria angustifolia*.

Fiorinia expansa, sp. nov. Plate II., figs. 8–13.

Female puparium snowy-white, very broadly pyriform; length, about $\frac{1}{25}$in. Viewed dorsally, only one pellicle (that of the larva) can be seen at the end; but on turning over the puparium the second pellicle is seen to occupy nearly all the length and about half the width, and to be much larger than the adult female. Both pellicles are yellow, the second being lighter-coloured than the first. The white secretion spreads laterally from the second pellicle more conspicuously than is usual in the genus. From the larval pellicle there usually spring a number of very delicate, longish, curling white threads, which are scarcely to be made out except with a strong lens.

Male puparium snowy-white, with a single yellow terminal pellicle; form cylindrical, not carinated; length, about $\frac{1}{35}$in.

Adult female orange-yellow; elongated, smaller than the second pellicle, segmented; length about $\frac{1}{40}$in. The cephalic extremity is somewhat cylindrical and truncate, a feature which is not uncommon in *Fiorinia*. The abdominal extremity is also somewhat truncate, or even, in some specimens, slightly concave. There is an exceedingly minute median depression, but no lobes; on each side are two or three very short spines. There are no groups of spinnerets.

The second female stage (the pellicle) is elongate, distinctly segmented; length about $\frac{1}{30}$in. The abdominal extremity is much like that of the adult, truncate and without lobes.

Male unknown.

Hab. In Australia, on *Melaleuca linariifolia*. Mr. Froggatt sent me specimens from Bankstown, near Sydney.

At first sight the puparium of this insect suggests a *Chionaspis*, and the non-carinated male puparium suggests a a *Mytilaspis*. It is easy also to mistake the large second pellicle for an adult, and this seems to indicate still more a

Mytilaspis. But on careful examination, and especially when the puparium is overturned, and the insect and pellicles are viewed by transmitted light, the true generic position becomes clear. I think there is no doubt that the species is distinct, from its smallness, from the broad pyriform puparium, from the delicate threads on the larval pellicle, and from the characters of the abdominal extremity.

Genus Ischnaspis, Douglas.

Ischnaspis filiformis, Douglas. Douglas, Ent. Mo. Mag., 1887, p. 21.

Specimens of this insect have been sent to me by Mr. Quinn, from Adelaide, South Australia. They were plentiful on palms in hothouses at that place.

The species is clearly tropical, reported originally from Demerara and found all over the West Indies. Probably it also exists in many other localities.

Genus Poliaspis, Maskell.

Poliaspis exocarpi, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 17.

I have received specimens of this species from Mr. Froggatt, on *Oxylobium trilobatum*, from Bankstown, near Sydney. These exhibit a very slight variation from the type, the lower median group of spinnerets having three, or sometimes four, orifices. But this is not sufficient to separate them from the species. The puparia have a glistening, burnished appearance.

Later specimens on *Dillwynia* sp., from Oatley, near Sydney, have similar characters.

Sub-family LECANINÆ.

Section LECANIO-DIASPIDÆ.

Genus Ctenochiton.

Ctenochiton eucalypti, sp. nov. Plate III., figs. 1–12.

Test of adult female waxy, whitish or yellowish-white. The central region is formed of a thick pyramidal mass of wax, the sides of which are indented, the angles rounded, and the whole sometimes cruciform, sometimes irregularly triangular: from this central mass to the margin the test is thinner, formed of an elliptical ring of irregularly-hexagonal plates and an outer ring of pentagonal plates with the bases outwards, and along the bases of these is a row of small, more or less rectangular plates, forming a fringe. The whole test is very convex in the latest stage, but flatter in the early adult, and in this earlier state the central mass is much thinner. The test just covers the insect.

Test of male pupa white, more glassy than that of the female: the form is elongated-elliptical, the sides nearly parallel, the dorsum convex: the central region is formed of three plates, of which the two anterior are quadrangular with indented edges, and the posterior one triangular; surrounding these is a ring of rather large quadrangular plates, on the outer edges of which is a small fringe as in the female. Length of male test about $\frac{1}{10}$in.

Adult female dark-brown. In the earlier state it is flattish, but at gestation becomes convex with a flattened margin. The form is broadly elliptical; length when fully developed about $\frac{1}{7}$in. Antennæ of six joints: the first short, the second much the longest, with a "false joint" at about two-thirds its length, the third and fourth the shortest and equal, the fifth and sixth rather slender and equal: the second and third joints bear three or four hairs, the sixth has several. Feet rather long: the tarsus is about half as long as the tibia, and is somewhat thicker, having a rather swollen appearance: claw moderate; the digitules are slender: on the trochanter is a long hair, and on the inner edge of the tibia a few fine short spines. Abdominal cleft and lobes moderate. Rostrum small; mentum monomerous. On the margin, near the four thoracic spiracles, are four semicircular indentations formed by chitinous bands, each bearing three cylindrical spines. All round the margin is a row of numerous fine longish hairs. There do not seem to be any dorsal spinnerets.

Female of the second stage covered by a thin white waxy test of irregular segments, which are very brittle and frequently almost all broken off, so that the insect in this stage seems almost naked: the fringe is very small. Form elongate, regularly elliptical, the margin not wavy; length about $\frac{1}{10}$in. Antennæ of six joints. Feet slender, the tarsus somewhat swollen as in the adult. Margin bearing numerous hairs; but in the spiracular indentations there is only one spine. Abdominal cleft and lobes normal.

Larva yellowish-brown, flattish, active, broadly elliptical. Length about $\frac{1}{5}$in. Antennæ of six subequal joints, of which the last is the longest: this last joint is irregular and tapering to a slender tip, and bears several longish hairs. Feet with a slightly swollen tarsus: all the digitules are fine hairs. On the margin of the body are numerous hairs, of which the last six on each side of the abdominal cleft are much the longest. The abdominal lobes bear long setæ.

Adult male red in colour or sometimes brown. Length, including spike, about $\frac{1}{16}$in. The wings are iridescent, and the nervure deep-red. Antennæ rather long, with ten long slender joints, each bearing numerous hairs. Feet slender. The ab-

dominal spike is short, thick, and slightly curved. The insect emerges from the pupal test by lifting up the posterior triangular plate.

Hab. In Australia, on *Eucalyptus siderophloia* (large-leaved ironbark). Mr. Froggatt sent me specimens from Wallsend, Newcastle, N.S.W.

This is the first species of the genus *Ctenochiton* which has been reported outside New Zealand. It is evidently so near, in the characters of its tests, to the New Zealand species *C. flavus* and *C. fuscus* that I have not any doubt as to the genus. The marginal hairs, the form of the feet in the adult, the spiracular spines, the form of the second stage, and the marginal hairs of the larva are distinguishing characters. The median thick mass of wax on the adult female test approaches that of *C. flavus;* but the insect is clearly distinct. Some specimens also outwardly resemble the New Zealand *C. dacrydii.*

Ctenochiton rhizophoræ, sp. nov. Plate III., figs. 13–17.

Test of adult female (where observed) consisting, on the margin, of a flat greyish-white plate of wax, which on the median dorsal region rises up in a lofty pyramidal mass of irregularly-triangular form : this mass is slightly rough on the top, and at the sides exhibits many striations as if it were built up of successive layers; but no air-cells are apparent. At the margin the wax extends in a very fragmentary fringe.

Female of the second stage covered by yellowish-brown wax, which at the earliest period seems to be very thin and fragmentary, and becomes thicker as the insect grows, until at last it forms broad quadrangular plates round the margin, with a median longitudinal mass which is less elevated than in the adult. This test also extends in a small fringe, but the whole of it appears to be very brittle, so that amongst many specimens only one or two may exhibit it entire.

Adult female (where observed) of clearly Lecanid form, greyish-brown in colour; length about $\frac{1}{8}$in. The specimen seen is acuminate anteriorly. Antennæ and feet not observed. Round the margin runs a row of rather long spines. Abdominal cleft and lobes normal. Probably the dorsal region would be considerably convex.

Female of the second stage yellowish-brown, flattish, elliptical; length from about $\frac{1}{40}$in. in the early part of this stage to about $\frac{1}{12}$in. later on. Antennæ of six joints, of which the third and sixth are the longest and bear a few hairs. Feet presenting no special character; the tibia is as usual shorter than the tarsus; the digitules seem to be fine hairs. Round the margin of the body is a row of long slender spines as in

the adult, and these are usually rather longer at the abdominal than at the cephalic end.

Larva distinctly Lecanid; form regularly elliptical; length about $\frac{1}{65}$in. Antennæ of six subequal irregular joints, the last bearing some long hairs. Feet normal; digitules fine hairs. Margin of the body minutely serrulate and bearing a few scattered very short fine hairs. Spiracular spines rather strong. Mentum monomerous.

Hab. In Australia, on *Rhizophora mangle* (mangrove). My specimens were sent by Mr. Koebele, from Brisbane, Queensland.

I am in a manner breaking, in this instance, a rule which I have laid down for Coccid study, by erecting a new species on the observation of a single specimen in the adult stage. Yet probably no inconvenience will result, as I have between thirty and forty specimens of the second stage, and have examined about a dozen larvæ. The characters of these are so clearly those of a *Ctenochiton* that there is no doubt of the genus; and, as they do not resemble any of the New Zealand forms, nor the only other species from Australia (*C. eucalypti*), I venture to think that the rule may be disregarded for once, more especially as I have only given very general features for the adult and its test. The species will take rank near to the New Zealand *C. flavus*, from which it differs in size, colour, arrangement of test, and in the anatomical features of the second stage. From *C. eucalypti* (Australia) it differs in colour, in the characters of the second stage, and in the larva, which is smaller and has not the long marginal hairs on the abdomen. I suppose, from the food-plant, that the insect must live either close to the water, or sometimes even submerged.

I do not know the adult male nor the male test.

Genus CERONEMA, Gen. Nov.

Female insects in the adult stage covered wholly or partially by tests of threads more or less closely woven, neither glassy nor cottony nor felted, never forming homogeneous plates. No fringe. Form of insect Lecanid, with normal cleft and lobes.

Larva Lecanid, showing cleft and lobes.

Male pupa covered by a glassy test of normal Lecanid form, composed of plates more or less homogeneous.

The formation of this genus has been necessary to include a species from Australia, in which the test appears to be intermediate between those of *Ctenochiton* or *Inglisia* and those of *Signoretia* or *Eriopeltis*, being too loosely woven for the former and too waxy for the latter. In using here the term "waxy," I do not assert that the secretion of *Signoretia*

essentially differs from that of *Ctenochiton;* yet one is conveniently denoted by the word "cotton," the other by "wax."

Ceronema banksiæ, sp. nov. Plate IV., figs. 1–13.

Adult female secreting dorsally a thick mass of white waxy threads, which, when closely examined, are short cylinders. These are produced from pores at or near the margins of the body, and not on the median region, so that the insect is only partially covered, the mass of wax curling thickly inwards from the edges, but leaving the median dorsum visible. At the edges the test spreads out all round in a much looser arrangement of threads, but there is no fringe properly so called. Beneath the insect the threads are pressed into a closer mass between it and the leaf, but the median ventral region is also clear. Thus the insect lies, as it were, in a ring of white threads flattened beneath and curling over above. Diameter of test averaging about $\frac{1}{6}$in.

The second stage of the female and the larva have no tests.

The male pupa is covered by a white, glassy test of the usual elliptical Lecanid form, composed of plates, the posterior plate hinged for egress. Length of test about $\frac{1}{12}$in.

Adult female dark red-brown, of normal Lecanid form, flattish, very slightly convex, without dorsal carinæ. Length about $\frac{1}{8}$in. Antennæ of six joints, of which the third is much the longest, next the first, the rest shorter and subequal. In the third there is a "false joint," and on the sixth are some hairs. Feet small and rather slender: I have not been able to make out the digitules, but they appear to be all fine hairs. Abdominal cleft and lobes, and anal ring, normal. The four spiracular marginal depressions are semicircular, with a chitinous band bearing a few club-shaped spines. On the margin of the body is a row of short fine hairs. The dorsum, except on the median region, which is almost unmarked, bears great numbers of oval pores, the orifices of tubular canals, and close to the margin is a row of larger canals ending in larger pores, which are multilocular. The canals are smaller and more closely set as they approach the median region.

Female of the second stage yellowish-brown, flattish, elongated-elliptical, with a faintly-indicated longitudinal dorsal carina. Length about $\frac{1}{25}$in. Antennæ and feet and abdominal cleft as in the adult. The dorsal pores are absent, but the marginal row of canals with multilocular orifices can be seen.

Larva brownish-yellow, flattish, elongated, narrowly elliptical, naked, active. Length about $\frac{1}{40}$in. Abdominal lobes normal of *Lecanidæ*, the setæ rather long. Antennæ very long and slender, with six long joints, the sixth especially long.

Feet long and slender; digitules fine hairs. Margin of body very minutely serrated.

Adult male unknown.

Hab. In Australia, on *Banksia serrata*. Mr. Froggatt sent me eight adults and a few others from Manly, near Sydney. He informed me that the insect seems to be very rare; but hopes to be able at a future time to procure more.

I have no hesitation in separating this species and genus from other *Lecanio-diaspidæ*, the characters of the secreting pores and therefore of the secreted test being so different. If it could possibly be placed in a known genus, I suppose that would be *Ceroplastes;* yet I know of no *Ceroplastes* where the test is so loosely constructed as in *C. banksiæ*. Of course the fact of the insect being only partially covered by the waxy threads is not a sufficient generic character: it will amply suffice for specific distinction, because it depends upon the absence of pores in the median dorsal region. The antenna of the larva is somewhat unusual in its length and slenderness.

Section LECANIDÆ.

Genus Lecanium.

Lecanium patersoniæ, sp. nov. Plate V., figs. 1–3.

Adult female reddish-brown, sometimes yellowish-brown; flat, elliptical with nearly parallel sides; length, about $\frac{1}{8}$in. There is a distinct longitudinal median carina, and frequently two transverse carinæ less distinct. The dorsum is sometimes naked, but usually covered with very thin white waxy meal, scattered in minute patches. Antennæ of seven joints, of which the third is the longest, the second next, the rest shorter and subequal: the last bears several hairs. Feet rather slender, of normal form; digitules slender. The margin of the body bears numerous short hairs. On the dorsal epidermis there is seen a row, all round the body, a short distance within the margin, of oval or circular pustules, not always at regular distances, but sometimes as in pairs: there seem to be on an average from thirty-six to forty of these on each side. There are also, scattered over the dorsum, great numbers of smaller oval spots. The pustules are by no means distinctly visible, and both they and the small spots are scarcely to be made out until the insect is rendered more or less transparent.

Second stage of female, and larva, not observed.

The male pupa is covered by a test of the usual elongated-elliptical form, composed of segments of thin white wax, the posterior segment hinged for egress. Length of the test about $\frac{1}{10}$in. These male pupæ seem to be more numerous than the females.

Adult male unknown.

Hab. In Australia, on *Patersonia glabrata.* Mr. Froggatt sent me specimens from Sydney.

I think that this is a clearly distinct species, from the row of large pustules near the margin, and the numerous small oval dorsal spots. There is a species—*L. pruinosum,* Coquillett ("Insect Life," June, 1891)—reported on apricot in California, which presents a thin covering of white powder as in *L. patersoniæ;* and Mr. Coquillett places his insect very close to *L. caryæ,* Fitch (although Signoret, in his description of the latter, makes no mention of the powder). But both of these are very convex, and do not seem to exhibit either spots or pustules.

L. patersoniæ appears to be frequently subject to attacks by parasitic fungi, and I possess specimens in which the fungus can be seen permeating the whole body of the insect, and especially infesting the pustules. The fungus consists of matted and jointed filaments, and does not seem to belong to the groups of *Cordyceps* or *Empusa,* but rather to be Hyphomycetous, like the fungi infesting Lecanids in New Zealand (see N.Z. Trans., 1883, vol. xvi., p. 1883, and Scale-Insects of N.Z., 1887, p. 22, and plate xxiii.).

Lecanium scrobiculatum, Maskell. N.Z. Trans., vol. xxv., 1892, p. 221.

I find, when examining an insect, which I am naming in this paper *Lec. pingue* (below), that I have omitted in my description of *L. scrobiculatum* to mention the longitudinal row of dorsal tubercles which are visible in that species, as well as in *L. pingue.* These tubercles, which are from four to six in number, are not at all noticeable in all specimens, but they are sufficiently constant to form a specific character.

Lecanium pingue, sp. nov. Plate V., figs. 4–7.

Adult female elliptical, convex; colour dark-brown, but with meandering raised yellowish or greyish ridges which divide the dorsum into many small pits: these ridges have a soft, moist, greasy appearance, and the whole dorsum frequently looks as if covered with some oily matter. The median dorsal region bears a longitudinal row of circular raised tubercles, generally six in number. Length of the insect about $\frac{1}{10}$in. Antennæ very small and short: there seem to be six joints, of which the third is the longest, but they are not clearly defined; the sixth joint bears a few hairs. Feet entirely absent. Anal cleft and lobes normal. Rostrum small; mentum round, monomerous; setæ short. Epidermis covered with numbers of circular spinnerets which are the orifices of short cylindrical tubes.

Larva yellowish-red, elliptical, active; length about $\frac{1}{45}$in. The median dorsal region usually exhibits a raised longitudinal ridge, not divided into distinct tubercles. The abdominal cleft, lobes, and setæ are normal. Antennæ rather thick, and very long, almost half as long as the whole body; they have six irregular joints. Feet also long, with thick tibia and tarsus.

Adult male and male pupa unknown.

Hab. In Australia, on *Dillwynia juniperina*. Mr. Froggatt sent me specimens from Bankstown, near Sydney.

This insect approaches very closely to *L. scrobiculatum*, Mask. (1892); the differences are the absence of the feet in the adult, the colour, and the greasy appearance. The two last are of small importance, and if it were not for the first I should consider the insect as merely a variety. I have already mentioned that *L. scrobiculatum* has dorsal tubercles. Full certainty as to the position of *L. pingue* may perhaps be attained when the larva of *L. scrobiculatum* shall have been found.

Lecanium armeniacum, Craw.

I do not know where any description of this form is to be found. But Mr. Ehrhorn has sent me specimens from California, and tells me that it is there a pest on the apricots, plums, and peaches. From these specimens I believe it to be merely a rather smaller form of *L. persicæ*, Sign., if indeed it can lay any claim to be considered even a variety. The habit of erecting new species without proper description and comparison is a pernicious one; still more so if mere colour or food-plant be taken as the basis.

Lecanium tessellatum, Signoret.

This occurs at Adelaide, on *Palms* in hothouses. My specimens are from Mr. Quinn, who tells me that it attacks scarcely any other plants in that locality.

Lecanium hemisphæricum, Targioni-Tozzetti.

This insect occurs plentifully in hothouses in Adelaide on *Eranthemum variegatum*. I have had specimens from Mr. Quinn.

Genus Pulvinaria.

Pulvinaria mammeæ, sp. nov. Plate V., figs. 8–11.

Adult female reddish-brown, covered with thin greyish-white meal: the colour fades to yellowish in extreme age. The form before gestation is flattish, regularly elliptical, with sometimes a faintly-raised longitudinal dorsal ridge. The length at this period is about $\frac{1}{3}$in. At gestation it shrivels

considerably, as usual in the genus, becoming much wrinkled. The ovisac is large, snow-white, irregular, forming a mass of loose cotton behind the insect. The antennæ have eight joints, of which the third is the longest, then the second and fourth, then the first and fifth, the last three much the shortest: all the joints bear a few hairs, and there is one on the last much longer than the rest. The feet have a rather arched tarsus: on the inner margin of both tibia and tarsus are a few slender spines; the trochanter has one very long hair; the tarsal digitules appear to be wanting, those of the claw being long and rather dilated. Abdominal cleft and lobes normal. The mentum is round and monomerous.

Female of the second stage, larva, and male not observed.

Hab. In Sandwich Islands, on *Mammea americana*. My specimens are from Mr. Koebele.

The food-plant of this species, according to Johnson's "Gardener's Dictionary," is the "mammee apple" of the West Indies and South America. I do not know whether it is indigenous or not in the Sandwich Islands. Mr. Cockerell, in a list of the Coccidæ of the neotropical region (Jour. of Trinidad Field Nat. Club, 1894), mentions five species of *Pulvinaria*, none of which, certainly, is *P. mammeæ*. This insect is quite the largest of the genus known to me at present.

Sub-family COCCINÆ.

Section ACANTHOCOCCINÆ.

Genus Prosopophora.

Prosopophora prosopidis, sp. nov. Plate VI., figs. 1–4.

Adult female covered by a waxy test which is subcircular, rather convex, buff-coloured; diameter averaging about $\frac{1}{7}$in. Surface of the test not quite smooth, but showing very indistinct traces of small irregular segmentations forming polygonal cells on each side of a median indistinctly-raised carina: there is no marginal fringe. No depression is visible on the twig when the insect is removed. There is a small posterior orifice in the test.

Male pupa covered by a buff-coloured, waxy, elliptical test, of which almost the whole is corrugated like that of the female, but much more distinctly; at the posterior end is a shelving hinged plate for egress of the insect. Length of the male test about $\frac{1}{18}$in.; width about $\frac{1}{30}$in.

Adult female really red in colour, but under a lens or to the naked eye bluish-purple, being covered with thin white meal; it fills the test, but shrivels at gestation into a shapeless mass: the proper form is subcircular, convex dorsally, and slightly concave ventrally. Antennæ of eight joints of irregular length; the last always the shortest, and bearing a

few hairs. In all the specimens examined (ten), one of the antennæ was shorter and rather thicker than the other. Feet absent. Mentum monomerous. Anal tubercles very minute, each bearing a seta and a few spines; anal ring bearing several hairs, probably ten. Epidermis covered with large circular simple spinnerets, which are very numerous on the abdominal segments and less so on the thoracic: those on the cephalic segments bear tubular processes. On the abdominal segments there are two ventral rows of circular marks, larger than the spinnerets, each containing many minute orifices; but there seem to be none of these on the cephalic region.

Early stages and adult male not observed.

Hab. On *Prosopis julifera*, Arizona, North America. Mr. Koebele has furnished me with specimens.

This insect is clearly allied to *P. dendrobii*, Douglas (Ent. Mo. Mag., Aug., 1892, p. 207); but differs in a few particulars. The test is lighter-coloured, more circular, and, from the circular form, appearing a good deal larger than in that species; and the corrugations are much less distinct. The large round marks mentioned above (or, as Mr. Douglas calls them, the "perforated discs") are absent from the anterior region; and I cannot see any trace of figure-of-eight spinnerets. I shall not object if it is proposed merely to consider this a large variety of *P. dendrobii;* but for the present leave it as distinct. I understand that *Prosopis julifera* is a South American tree.

Genus Planchonia, Sign. Asterolecanium, Targioni.

It seems now scarcely worth while to prolong a controversy which has continued for the past few years amongst students of Coccids regarding the exact status of the genus *Planchonia*. In my paper of 1893 I discussed this question, and expressed the opinion—first, that *Asterolecanium* was really only a synonym of *Planchonia;* and, second, that a large number of described species were really only *Planchonia fimbriata* or varieties of it. Some of my friends demur to these views, having apparently very much reverence for external colour or size. With regard to the first point, I am unable to depart an inch from the position taken up last year—namely, that no considerations whatsoever of a fancied "priority" ought to weigh with us as against clearness and common-sense. I agree entirely with a phrase of Mr. Douglas (in a letter to me of this year): "Far too many names have been admitted only on what is termed 'prescriptive right,' but we should not go on sinning with our eyes open." *Asterolecanium* conveys an erroneous idea, and no fetish-worship of priority ought to make us adhere to it. Consequently, I persist in discarding it altogether in favour of *Planchonia*.

With regard to the second point, I am willing, in deference to the opinions of some of my friends, to withdraw somewhat from my position of last year, although not entirely; and the following series will represent what I believe to be the true relationships of the genus:—

A. Tests round or oval,—

Planchonia fimbriata, Boyer de Fonscolombe. Synonyms: *Asterolecanium quercicola*, Bouché; *Asterolecanium aureum*, Boisduval; *Planchonia oneidii*, Cockerell; *Planchonia pustulans*, Cockerell; *Asterolecanium massalongianum*, Targioni (perhaps).
Planchonia fimbriata, var. *bambusæ*, Boisduval.
Planchonia epacridis, Maskell.
Planchonia stypheliæ, Maskell.
Planchonia ventruosa, Maskell.
Planchonia delicata, Green (MS.).
Planchonia arabidis, Lichtenstein, doubtful.
Planchonia hederæ, Lichtenstein, doubtful.

B. Test elongated,—

Planchonia miliaria,* Boisduval. Synonyms: *Asterolecanium palmæ*, Cockerell; *Asterolecanium urichi*, Cockerell.
Planchonia miliaria, var. *longa*, Green (MS.).
Planchonia solenophoroides, Green (MS.).

C. Test irregular,—

Planchonia bryoides, Maskell.

Strictly speaking, I am still by no means satisfied that *P. epacridis* and *P. stypheliæ* ought to be considered as really more than varieties of *P. fimbriata*. But, on the whole, I will leave the genus as above. The separation or otherwise of the different species is, after all, a small matter: the most important point is that the absurd name *Asterolecanium* should be relegated to the limbo of oblivion.

Planchonia stypheliæ, Maskell. Maskell, N.Z. Trans., vol. xxiv., p. 24; vol. xxvi., p. 85.

The Rev. Mr. Thompson, of the Agricultural Department of Tasmania, has sent me specimens collected on a dwarf *Melaleuca* in North Tasmania which I cannot separate from *P. stypheliæ*, though perhaps the tests are rather greener in colour, and the fringes are less silvery-white, than in the type.

* This word has always been printed *miliaris;* but there is no such word (I think) in Latin. *Miliaria* means "like a grain of millet."

Planchonia ventruosa, sp. nov. Plate VI., figs. 5–11.

Test of adult female green, waxy, flat or sometimes slightly concave. The green colour is in the test itself, and not due to the insect showing through it. Form of test broadly elliptical, or with a very slight posterior tapering. Fringe pink or white.

Test of male glassy, greenish-white, elongated-elliptical, convex.

Adult female dull dark-red; form subcircular, or slightly tapering posteriorly; length, about $\frac{1}{20}$in., but rather variable. The dorsum is flat or slightly concave, the ventral surface somewhat prominently convex and wrinkled, the rostrum being situated at the apex, subcentral. Antennæ and feet absent, but the position of the antennæ is indicated frequently by two very small tubercles. Anal tubercles very minute, and only noticeable from the two short setæ. The margin of the body bears the usual rows of figure-of-eight spinnerets, from which springs a fringe, which is sometimes pink, sometimes white, apparently according as the bark of the tree is dark or light-coloured. The mentum is short and monomerous; setæ short.

Female of the second stage red; elliptical. The thin green test is more convex than in the adult.

Larva red, covered with thin fragmentary green wax; elliptical, tapering posteriorly; flattish; length, about $\frac{1}{60}$in. Anal tubercles prominent; setæ moderate. Antennæ short and thick, with six subequal joints. Feet moderately long and slender; digitules fine hairs. On the margin of the body is a row of strong spines, which bear a fringe of feather-shaped segments.

Male unknown.

Hab. In Australia, on *Acacia* sp. I have specimens from Adelaide, sent by Mr. Koebele, on twigs with dark-red bark, and in these the fringes of the adult are pink; others, from Sydney, sent by Mr. Froggatt, are on twigs with lighter and greyish bark, and the fringes are white; but otherwise the specimens are identical. This insect forms for itself depressions or pits in the bark, adapted to the convexity of its ventral surface; and, when it is lifted out, there remain slender, white, cottony trails, denoting the spiracular regions.

The flat or concave dorsum and the protruding ventral region distinguish this species. The test is very apt to fall off, contrary to the usual rule in this genus, where it is generally not easy to extract the insect; and a large proportion of the adults are naked. The variation in colour of the fringe, apparently according to the food-plant, is a point strongly in favour of my theory as to the relationships of *Planchonia*.

Genus Eriococcus.

Eriococcus araucariæ, Mask., var. **minor**, var. nov.

Sac of female elongate-elliptical, snowy-white, of very loose cottony texture; length about $\frac{1}{18}$in.

Sac of male of similar colour and form, but smaller and more closely woven; length about $\frac{1}{30}$in.

Adult female brown or yellowish-brown. Normal form elliptical, but shrivelling at gestation. Length about $\frac{1}{30}$in. Antennæ of six subequal joints as in type. Feet, anal ring, and anal tubercles as in type. Marginal spines rather shorter and stronger than in the type.

Adult male unkown.

Hab. In Australia, on *Kunzea* sp. Mr. Froggatt sent me specimens from Manly, New South Wales.

I can detect no character, except size, valid for separation of this form from the type which I reported, in 1878, from Norfolk Island.

Eriococcus multispinus, var. **lævigatus**, Maskell. N.Z. Trans., 1890, p. 20.

Mr. Froggatt has sent me specimens of this insect from Oatley, near Sydney, on *Epacris longifolia*. The species is readily distinguishable on account of the various numerous short, blunt, conical spines scattered on the dorsum.

Eriococcus pallidus, Maskell. 1884.

I have received from Mr. T. Kirk, F.L.S., some specimens on *Metrosideros robusta* (locality not stated) in New Zealand, which on examination prove to have the slender spines and the elongated third joint of the antennæ which characterize this species. The marginal spines are normal, but those on the dorsum are scanty and small; and the cottony sac is rather dark-coloured. This form seems therefore to approach the variety on *Fagus menziesii* (the last of the four mentioned in my paper of 1890, p. 21).

I find that I have not, in any of my papers, described the larva of this species, and therefore do so now. This stage does not appear to differ appreciably in the different varieties. The larva is pale-red in colour, the form normal of the genus; length about $\frac{1}{80}$in. The antennæ have six subequal joints, of which the fourth and fifth are rather the shortest. Feet rather thick; digitules fine hairs. Anal tubercles short, setiferous. The margin of the body bears a row of rather strong spines.

The colours of the adult females vary somewhat in the different varieties. The type form is greenish-grey, turning to brown at gestation: others are brown or red.

Eriococcus buxi, Boyer de Fonscolombe, var. **australis,** var. nov.

Adult females enveloped in a sac of white cotton, which averages $\frac{1}{10}$in. in length. The antennæ have six joints, of which the third is the longest. The digitules are all fine hairs.

Larva yellowish-brown, elliptical. The marginal spines are very small and inconspicuous.

Hab. In Australia, in the Botanic Gardens, Brisbane, on an unnamed plant. My specimens are from Mr. Froggatt.

I could perhaps mention a number of very minute characters in which this insect differs from the type which is reported from Europe on *Buxus sempervirens :* but the most important seem to be those here mentioned—the digitules of the adult (which in *E. buxi* are widely dilated), and the marginal spines of the larva (which in *E. buxi* are conspicuous). For the present I shall not consider these as sufficient to raise the Brisbane insect to specific rank; more especially as its food-plant may not be Australian, and in any case "Botanic Gardens" are localities for many exotic things.

Section DACTYLOPINÆ.

Genus Dactylopius.

Dactylopius eucalypti, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 35.

I have received specimens of this species (my first from New South Wales) from Mr. Froggatt, on *Eucalyptus siderophloia,* Newcastle. The adults were only few in number, but correspond with the type; the larvæ were numerous, and presented the characteristic feathery fringe of the species. Mr. Froggatt tells me that this insect is not uncommon on the same tree near Sydney, but that he has never seen more than one or two on a tree: it makes a red blisterlike mark on the leaf.

Dactylopius vastator, sp. nov. Plate VI., figs. 12–16.

Female insects covered by globular sacs of whitish or yellow cotton, which are frequently aggregated in large masses on the twigs. Diameter of sac about $\frac{1}{8}$in.

Sac of male pupa not observed.

Adult female dark-red or purple; slightly elliptical or subglobular; length about $\frac{1}{12}$in.; segments inconspicuous. Antennæ of seven joints, of which the seventh is the longest and largest, the fifth the smallest, the rest subequal: all the joints bear a few hairs, which are most numerous at the extreme tip. Feet moderately strong; tibia about one-third longer than the tarsus: there is not any long hair on the

trochanter, nor any terminal spike on the tibia; the tarsal and claw digitules are all fine hairs. Anal ring compound, with six hairs; anal tubercles inconspicuous, setiferous. Mentum dimerous, with some hairs at the end. Margin of body bearing a few small conical spines wide apart (sometimes absent), which are in pairs or threes on the abdominal segments; and similar spines are very sparsely scattered on the dorsum, where there are also some scattered fine hairs. Epidermis bearing many circular spinnerets of two sizes; those on the dorsal surface being twice as large as those on the ventral.

Larva dark-red, flattish, elliptical, active. Length about $\frac{1}{90}$in. Antennæ thick, with six joints, of which the last is the largest. Feet also rather thick; tarsus longer than the tibia; the digitules are all fine hairs. Anal tubercles normal, with moderate setæ. Margin of body with only a few very small spines.

Male unknown.

Hab. In the Sandwich Islands, at Honolulu; but said to have been introduced from Japan: on *Citrus* and a great many other trees and plants. My specimens have been sent to me by Mr. Koebele.

This insect belongs to the same series of the genus as *Dactylopius globosus*, Mask., or *D. graminis*, Mask., in which the female is enclosed in a cottony sac. The species to which it seems most nearly allied is *Dact.* (*Bergrothia*) *townshendi*, Cockerell, described in Annals and Mag. of Nat. Hist., November, 1893, from New Mexico. I cannot by any means accept "*Bergrothia*"; but the species in question appears to be quite near to that from Honolulu. I have been particular in describing the antennæ and feet, in which the principal differences exist. In the New Mexico insect the comparative lengths of the antennal joints are somewhat different, the digitules of the claw have "large knobs," and there is a long hair on the trochanter: there are also slight differences in the spinnerets and in the marginal spines. Mr. Cockerell does not describe the larva of *D. townshendi*, and merely says, regarding the cotton, "A small, oval species, covered by a white sac." For the present I shall leave my insect as separate.

The name which I have attached to this insect seems to be appropriate, whether it should turn out hereafter to be distinct or only a variety. For Mr. Koebele in his first letter to me says, "It has been introduced from Japan within the last three years, and hundreds of trees have been destroyed by it in Honolulu." And in a subsequent letter he says, "It is not confined to *Citrus* trees, but attacks almost any kind of shrubs and trees. For this reason no plants were allowed to leave Honolulu for the other islands for nearly two years. I

have seen no Coccid that is so destructive to trees as this species. During the summer the trees were actually loaded down with *Dactylopius*." It is quite satisfactory that he continues, "Fortunately the danger is over now, as we are sending out colonies of the best enemy for the same that can be found in Australia" (where his letter was written).

I am told that some one in America has informed the Sandwich Island people that this insect is a *Rhizococcus*, which is undoubtedly an error.

Section IDIOCOCCINÆ.

Genus Sphærococcus.

Sphærococcus stypheliæ, sp. nov. Plate VII., figs. 1–4.

Adult female covered by a semi-globular test of wax, which is yellow or with a faint pink tinge, though the general appearance on a twig is blackish, on account of the usual fungus growths. Diameter of test averaging about $\frac{1}{20}$in. The surface is rather rough.

Male pupa covered also by a waxy test, probably (but not certainly) similar to that of the female, but smaller.

Adult female dark-purple or dark-brown, filling the test; the dorsal region convex, the ventral flat or slightly concave. Diameter averaging $\frac{1}{25}$in. Antennæ atrophied, represented by two very minute tubercles. Feet also atrophied; but their places are occupied by six swollen tubercular short processes, which have much the appearance of the "lac-tubes" of *Tachardia*, having an orifice at the end, and being covered with numbers of circular glands. The rostrum is subcentral; the mentum is short and dimerous; setæ short. The anal ring is small, circular, and hairless; anal tubercles absent. Epidermis covered with numbers of circular spinneret-orifices, which are most numerous near the margins.

Female of the second stage not observed.

Larva yellow, flattish, active; length about $\frac{1}{50}$in. Form elliptical, tapering posteriorly. Antennæ of six short joints, subequal in length, but somewhat tapering. Feet moderate; digitules fine hairs. Mentum dimerous. Anal tubercles prominent, with moderate setæ. The margin of the body has a row of spines, which, in life, bear a fringe of short curling white wax.

Adult male brownish-red; length about $\frac{1}{45}$in. Antennæ of ten joints. Feet normal. Anal spike short.

Hab. In Australia, on *Styphelia* (*Monotoca*) *elliptica*. Mr. Froggatt has sent me specimens from Vaucluse, near Sydney.

The very peculiar processes which take the place of the feet in this insect clearly distinguish it. I had much doubt, when first examining it, whether it might not be a quite

abnormal species of *Tachardia*, for the glands on these processes make them strongly resemble "lac-tubes": but the absence of any "tail" and of the characteristic "spine" of that genus, the globular form, and the hairless anal ring seem to place it clearly in *Sphærococcus*.

Sphærococcus leptospermi, Maskell. N.Z. Trans., vol. xxvi., 1893, p. 92.

I find that in my description of this species no locality for it is given. I rectify the omission now. My specimens were sent by Mr. Froggatt on *Leptospermum lævigatum*, from Sydney.

Sphærococcus elevans, sp. nov. Plate VII., figs. 5–8.

Female insects burrowing under the bark of the plant, and raising the bark in a circular convex blister, the diameter of which averages about $\frac{1}{8}$in., and the upper surface seems to consist simply of the bark without secretion. The inner surface and the base of this "blister" are smooth, and seem almost as if plastered with very thin secretion. Some specimens of blisters reach $\frac{1}{4}$in. in diameter.

Female insect circular, yellowish in colour, lying on the centre of the base of the blister: the dorsum is flattish, being sometimes very slightly convex, sometimes very slightly concave, with a small brownish central boss. Diameter of the insect (which looks, indeed, much like a small, flat, yellow cake) about $\frac{1}{24}$in. The rostrum, beneath, is subcentral. Antennæ almost obsolete, being reduced to very minute tubercles at the cephalic extremity, each bearing a few short fine hairs. Feet entirely absent. Mentum round, monomerous. Anal tubercles absent; anal ring simple, hairless. Epidermis apparently without spinneret-orifices. When the insect has been treated with potash and mounted, the dorsal boss is seen to contain a number of brown leaf-like segments or divisions, radiating from the apex and forming a rather elegant arrangement: these rays do not seem to actually meet at the centre, but I have not been able to detect any orifice on the boss of an untouched insect.

Female of the second stage not certainly observed; but in three of the very smallest blisters I have found minute globular insects, with a diameter not exceeding $\frac{1}{100}$in., in which the only organs I could detect were very short thick feet, of which the tibia and tarsus were equal in length, and the claw very small. The colour at this stage was reddish-yellow.

Larva and male unknown. All the blisters which I received contained numbers of white eggs, and these seemed

to be quite healthy, but I could not succeed in hatching any larvæ from them.

Hab. In Australia, on *Eucalyptus dumosa*. Mr. French sent me specimens from Mildura (Victoria).

The blisters produced by this species are, I suppose, technically galls; but really they are but nests in which the insect shelters itself. The form of the female, the absence of anal tubercles, and the simple anal ring sufficiently define its generic position; and it is clearly distinct from the other known species.

Sub-family MONOPHLEBINÆ.

Genus Icerya.

Icerya koebelei, Maskell. N.Z. Trans., vol. xxv., 1892, p. 245.

I have received specimens of this insect from Mr. Froggatt, which agree entirely with my former ones, except that the dorsal pencil of cotton is yellow instead of white, and from the margin of the body there spring a great number of long, very slender, glassy, straight threads, while a few similar threads spring from various regions of the dorsum.

Genus Cœlostoma.

Cœlostoma immane, Maskell. N.Z. Trans., vol. xxiv., 1891, p. 49.

I have received from Mr. Koebele two specimens, found attached to *Eucalyptus* near Sydney, which seem to belong to this species, and to be a rather more advanced stage than that depicted in plate ix., fig. 12, of my paper of 1891. They resemble that figure in nearly every particular, but are larger, and the abdomen is considerably more inflated ventrally. The antennæ have ten joints; there is no rostrum; and the tarsi are much shorter than the tibiæ: I am therefore confirmed in my opinion that these are early adult females of *C. immane*, but more developed than the one shown in fig. 12 above mentioned.

Mr. Newstead informs me that in the South Kensington Museum there are some specimens apparently of this species, labelled simply "from Australia," without any name.

Cœlostoma australe, Maskell. Proc. Linn. Soc. N.S.W., 1890, p. 280.

This species appears to be not uncommon in New South Wales and Queensland. Some specimens which I have received have rather abundant white meal on the dorsum. The *early* adult stage seems to have antennæ of ten joints, but possibly the first two are conjoined. The principal feature by which the species can be distinguished (besides the

absence of a rostrum) is the presence of the dermal oval cells, with the central small cone: these cannot be well observed until after treatment with potash.

In a mounted specimen of the cephalic region of an adult female I observe that the buccal orifice, which (as in all this genus) may be detected between the first pair of feet, is the termination of a rather long and wide tubular organ, the other end of which appears to end in two muscular fibres situated in the interior of the body, and to be there connected with the intestinal canal, which, however, has not resisted the action of the potash used in the preparation, and has therefore disappeared. This buccal orifice is not to be detected, even with very careful scrutiny, until the insect is rendered transparent, a thing which is not easily done, as it requires prolonged boiling in potash before the internal organs can be washed out.

Sub-family BRACHYSCELINÆ.

Genus Tachardia, Signoret. Carteria, Signoret.

Dr. Signoret, in 1876, altered his original generic name of *Carteria* to *Tachardia*, on account of the former name having been appropriated earlier to some genus of Mollusca or of Crustacea. I think, myself, that the change was a needless refining, and that less confusion would have resulted if the original name had been retained, for nobody could mistake a Mollusc for a Coccid; and if it had been made by anybody but the first author I should probably have disregarded it. However, we must accept the alteration, under the circumstances.

Tachardia decorella, Maskell. N.Z. Trans., vol. xxv., 1892, p. 247.

Specimens of this insect have been sent to me during the year by Mr. Koebele and Mr. Froggatt from various places in New South Wales, and by Mr. French from Mildura, in Victoria. They occur on various native plants, and the species is evidently not uncommon. Mr French tells me that the people at Mildura call it the "native cochineal." The name is scarcely appropriate. "Native shellac" would be better, as the insect (and also *T. melaleucæ*, Mask., 1891, and *T. acaciæ*, Mask., 1891) is closely allied to the shellac insect of Africa and Asia.

Genus Frenchia, Maskell.

Frenchia semiocculta, sp. nov. Plate VII., fig. 9–19.

Adult female not forming a prominent gall, but occupying a cavity under the bark of a twig over which usually a slight

swelling of the bark may be detected. In the middle of this swelling may be seen a very minute pustule with an orifice in it. Usually this pustule seems to have nothing in the orifice, or perhaps some particles of dust, or sometimes the exuviæ of a larva; but sometimes the "tail" of the insect (described below) protrudes through it, and emerges to perhaps $\frac{1}{100}$in., looking like a very minute soft yellowish finger with a red tip pushed through the bark. In the early adult state the insect is thus only just beneath the bark, but later it burrows much deeper, and the cavity in which the female at gestation lies is frequently hollowed out of the wood itself. In this latest state it requires close examination to detect the position of the insect, as the pustule has almost disappeared, and the swelling of the bark is scarcely noticeable.

Male pupa occupying a much more prominent gall than that of the female. This is a conspicuous excrescence on a twig, often congregated in bunches of half a dozen, more or less cylindrical, generally dark-coloured, hollow, with a terminal orifice, of which the lips are circular and thick. The height of this tubular gall frequently reaches $\frac{1}{12}$in.

If the bark round one of the small pustules above mentioned is carefully lifted and turned over, the adult female in its early state may be found lying on the wood (or sometimes will be lifted off with the bark). The body is subcircular; diameter, about $\frac{1}{28}$in.; colour yellowish, or with a tinge of red. The ventral surface is slightly concave; the rostrum, which is very small, is central, and placed on a small boss; the rostral setæ are very short. The antennæ and feet are entirely absent. The dorsal surface is very slightly convex, and from about the centre springs a subcylindrical process or "tail," which fits into the short tube through the bark, and, as mentioned above, sometimes protrudes through the orifice. This tail is bluntly rounded at the end, and the extremity is usually of a red colour. After preparation, a small, simple, hairless, circular anal ring is seen near the end of the "tail," and at the extreme tip there are two very minute short spines.

The foregoing is the *early* adult stage, and the "tail" is doubtless protruded through the orifice in the bark to facilitate the access of the male. After impregnation the female, as stated above, burrows much deeper in the twig. At gestation the insect becomes dull-red in colour, and has increased a good deal in size, reaching $\frac{1}{10}$in. in diameter. It then becomes nothing more than a bag full of eggs and larvæ, and scores of the latter may be found crawling all about in the cavity. The "tail," in several of the specimens observed, seems to have rotted or broken off, leaving a hole in the body through which the larvæ emerge; but in others it existed, although much reduced. The only organ visible is the rostrum, which is the

same as in the early state. The mentum is small, globular, and monomerous.

Between the female and the bark, both in the early and in the late adult state, there is a thin white waxy indusium, which is sometimes fragmentary, but at others fairly complete, with a prolongation to cover the tail.

Second female stage not observed.

Larva greenish, or yellowish, or sometimes slightly red. Length, about $\frac{1}{80}$in. Form broadly elliptical, distinctly segmented; margin minutely crenulated. Antennæ short, with six joints, of which the fourth and fifth are the shortest, the rest subequal: on the last joint are several hairs, of which two are rather long. Feet moderate; the digitules are long, fine hairs. There are two very minute anal tubercles, with long setæ. The dorsum bears two longitudinal rows of large figure-of-eight spinnerets.

The male pupa occupies the tube in the prominent gall above mentioned, but between it and the tube is a white, thin, elliptical, waxy test, which splits in half to permit the egress of the adult. Often galls can be found containing only the two empty halves of this test. The pupa appears to be elliptical, brown, and flattish; but the specimens observed were not in good order. Attached to one of them were the exuviæ of a larva, in which the antennæ had only four joints. Perhaps this may be a distinction between male and female larvæ.

Adult male brown, with iridescent wings. Length about $\frac{1}{30}$in. The antennæ are short, with only eight joints, of which the first is short and round, the second longest, the rest diminishing gradually: on the last joint there are four knobbed hairs. Feet normal; anal spike short.

Hab. In Australia, on *Casuarina* sp. Mr. Froggatt has sent me many specimens from Thornleigh, near Sydney.

Although the very inconspicuous gall formed by this insect (which indeed is almost entirely subcortical) differs considerably from that of *F. casuarinæ* (1891), yet its generic position is very clearly defined by the "tail," by the waxy indusium of the adult female, and by the figure-of-eight spinnerets of the larva. The male pupa forms a decided gall. The discovery of this species is very satisfactory, as indicating the correctness of my view in 1891, when I decided that *F. casuarinæ* might fairly form the type of a new genus.

Many of the male galls of *F. semiocculta* contained numbers of fat, white, soft grubs, which I presume belong to some dipterous insect.

At the risk of wearisome repetition, I cannot help again asking the question: Can anybody suggest an explanation of the burrowing powers of insects such as this? Here is an

insect absolutely, in its adult state, devoid of any visible organs, except its rostrum and setæ, and yet it is precisely in that adult state that it works its way deep into hard wood and digs out a cavern for itself. Before impregnation by the male it lies scarcely buried by the outer bark of a twig; at gestation it is found deep down in the wood. It is, of course, easy enough to say that the thing must be done "by some chemical action"; but what action? what chemical product? what secreting organ exists for the purpose?

EXPLANATION OF PLATES I.–VII.

PLATE I.

Fig. 1. *Aspidiotus ceratus*, pygidium of female.
Fig. 2. *Aspidiotus vitiensis*, pygidium of female.
Fig. 3. *Aspidiotus unilobis*, pygidium of female.
Fig. 4. *Aspidiotus extensus*, adult female, dorsal view.
Fig. 5. „ pygidium of female.
Fig. 6. *Aonidia fusca*, insects on twig.
Fig. 7. „ puparia, female and male.
Fig. 8. „ diagram showing adult female smaller than second pellicle.
Fig. 9. „ pygidium of female.
Fig. 10. *Mytilaspis nivea*, pygidium of female.
Fig. 11. *Mytilaspis striata*, puparia, female and male.
Fig. 12. „ pygidium of female.

PLATE II.

Fig. 1. *Mytilaspis lactea*, puparia, female and male.
Fig. 2. „ pygidium of female.
Fig. 3. *Chionaspis prunicola*, puparia, female and male.
Fig. 4. „ adult female, dorsal view.
Fig. 5. „ pygidium of female.
Fig. 6. *Chionaspis xerotidis*, insects on plant.
Fig. 7. „ puparia, female and male.
Fig. 8. *Fiorinia expansa*, insects on twig.
Fig. 9. „ insects on leaf, enlarged.
Fig. 10. „ diagram of arrangement: *a*, larval pellicle and threads; *b*, second pellicle; *c*, adult female; *d*, fibrous secretion.
Fig. 11. „ puparium of male.
Fig. 12. „ pygidium of female.
Fig. 13. „ second pellicle.

PLATE III.

Fig. 1. *Ctenochiton eucalypti*, insects on leaf.
Fig. 2. „ tests of female, dorsal view.
Fig. 3. „ test of female, side view.
Fig. 4. „ test of male, dorsal view.
Fig. 5. „ antenna of female.
Fig. 6. „ foot of female.
Fig. 7. „ spiracular spines of female.
Fig. 8. „ female, second stage, dorsal view.
Fig. 9. „ larva.
Fig. 10. „ antenna of larva.
Fig. 11. „ foot of larva.
Fig. 12. „ abdominal spike of male.

Fig. 13. *Ctenochiton rhizophoræ*, test of female, dorsal view.
Fig. 14. „ test of female, side view.
Fig. 15. „ female, second stage, dorsal view.
Fig. 16. „ larva.
Fig. 17. „ foot of larva.

PLATE IV.

Fig. 1. *Ceronema banksiæ*, insects on leaf.
Fig. 2. „ adult female, dorsal view.
Fig. 3. „ test of male, dorsal view.
Fig. 4. „ adult female, removed from test.
Fig. 5. „ antenna of female.
Fig. 6. „ foot of female.
Fig. 7. „ spiracular spines of female.
Fig. 8. „ arrangement of dorsal canals.
Fig. 9. „ dorsal canals near median region.
Fig. 10. „ dorsal canals near margin.
Fig. 11. „ diagram of female, second stage.
Fig. 12. „ larva.
Fig. 13. „ antenna of larva.

PLATE V.

Fig. 1. *Lecanium patersoniæ*, adult female, dorsal view.
Fig. 2. „ antenna of female.
Fig. 3. „ pustules, spots, and marginal spines.
Fig. 4. *Lecanium pingue*, insects on twig.
Fig. 5. „ adult female, dorsal view.
Fig. 6. „ antenna of female.
Fig. 7. „ diagram of larva, to show length of antenna and the anal lobes.
Fig. 8. *Pulvinaria mammeæ*, insect and ovisac on leaf.
Fig. 9. „ *early* adult female, dorsal view.
Fig. 10. „ antenna of female.
Fig. 11. „ foot of female.

PLATE VI.

Fig. 1. *Prosopophora prosopidis*, test of female, dorsal view.
Fig. 2. „ test of male, dorsal view.
Fig. 3. „ diagram of female, to show the circular discs and spinnerets.
Fig. 4. „ antenna of female.
Fig. 5. *Planchonia ventruosa*, insects in pits on bark.
Fig. 6. „ adult female, dorsal view.
Fig. 7. „ adult female, ventral view.
Fig. 8. „ adult female, side view.
Fig. 9. „ spinnerets.
Fig. 10. „ larva.
Fig. 11. „ fringe of larva.
Fig. 12. *Dactylopius vastator*, insects on twig.
Fig. 13. „ adult female, dorsal view.
Fig. 14. „ antenna of female.
Fig. 15. „ foot of female.
Fig. 16. „ larva.

PLATE VII.

Fig. 1. *Sphærococcus styphelicæ*, insects on twig.
Fig. 2. „ diagram of female, showing feet.
Fig. 3. „ foot of female.
Fig. 4. „ spinnerets.

Fig. 5. *Sphærococcus elevans*, blisters on bark.
Fig. 6. " female in cavity.
Fig. 7. " adult female, side view.
Fig. 8. " dorsal boss of female, after treatment.
Fig. 9. *Frenchia semiocculta*, male and female galls on twig.
Fig. 10. " female galls, one with protruding tail.
Fig. 11. " male galls.
Fig. 12. " *early* adult female, side view.
Fig. 13. " adult female, dorsal view.
Fig. 14. " extremity of tail, showing anal ring and setæ.
Fig. 15. " diagram of larva, showing spinnerets.
Fig. 16. " antenna of larva.
Fig. 17. " spinnerets of larva.
Fig. 18. " pupal indusium of male.
Fig. 19. " antenna of male.

ART. III.—*Illustrations of Darwinism; or, The Avifauna of New Zealand considered in relation to the Fundamental Law of Descent with Modification.*

By Sir WALTER L. BULLER, K.C.M.G., D.Sc., F.R.S., &c.

[*Read before the Wellington Philosophical Society, 27th June, 1894.*]

ON my retirement from the chair last year I had to apologize for my inability, owing to my hurried departure for England, to prepare the usual presidential address, but I then promised to deliver it later on; and by the courtesy of Major-General Schaw I am enabled to do so this evening in the form of a paper.

The Turks have a proverb which says that "the devil tempts the busy man, but the idle man tempts the devil." Bearing this in mind, I employed myself during a portion of my last six weeks' voyage from England in gathering together from my New Zealand notes and recollections, and carefully elaborating, certain facts and inferences that appear to me to bear directly on the great doctrine of the evolution of species by a natural process of descent with modification—that is to say, the ever-operating law of natural selection by variation and the survival of the fittest. And, as I must to-night take up some special subject for my address, it seems to me that I cannot perhaps do better than place before you, whilst the matter is fresh in my memory, the facts and considerations that presented themselves to my mind and the conclusions arrived at in the course of this interesting study. I do so the more readily because I find that the distinguished and gallant officer who succeeded me, and who still occupies the presi-

dential chair, in his inaugural address on the 14th June last, placed before the Society, in very picturesque language, views on this question of evolution which, in the light of modern science, I cannot but regard as unorthodox and, if I may use the term, pernicious. Major-General Schaw will not, I am sure, object to this personal reference, because in concluding his address he frankly admits that he has "thrown down the gauntlet and opened the door to criticism and discussion." I will give just one quotation by way of illustration. The President says, in his address, "In connection with these beetles I would refer to one passage in the Manual, and employ it as my text in what I wish to say on evolution, as it is in accordance with the theories of evolution which are now very generally accepted. The passage I refer to is at page 23, where this swimming-beetle is said to be 'only what a ground-beetle might naturally become if forced to lead an aquatic existence.' Now, my imperfect observation leads me to believe that any ground-beetle now forced to lead an aquatic existence—*i.e.*, being put into water—will not become a *swimming*-beetle, but, if it cannot get out, will inevitably become a *dead* beetle." Now, it seems to me that such a passage as that is worthy of the Dark Ages of Science. At any rate, it shows that the author of it has utterly failed to appreciate the plan and method of Natural Selection, for his argument entirely ignores the necessary postulate of Time. It is true that, later on in his address, he says, "We may undoubtedly accept as a working hypothesis, which has very strong arguments in its favour, that the remarkable unity in structural design which we discern in the animate world has been brought about in some way through heredity, or natural descent, with variations"; and, in commenting on the complete correspondence in all essential features between the Scriptural account and the facts of nature, he acknowledges that "Science fills out the pictures with endless and wonderful details, and teaches us that the days of creation were not days of twenty-four hours, but of many thousands of years." But here I fear his faith is weak; for, instead of limiting the Mosaic "days" to *thousands* of years, science claims space for vastly extended epochs of time. Sir Charles Lyell computes the age of the world, since the Cambrian period, at 270 millions of years, and in the opinion of most geologists this is a very moderate estimate. And Darwin says, "If the theory [as to the formation of the stratified rocks] be true, it is indisputable that before the lowest Cambrian stratum was deposited long periods elapsed, as long as, or probably far longer than, the whole interval from the Cambrian age to the present day, and that during these vast periods the world swarmed with living creatures."

Before proceeding to my subject, I may refer incidentally,

also, to a paper by one of our members, Mr. Coleman Phillips, "On a Common Vital Force," which appears in the last volume of our "Transactions." This essay affords pleasant and amusing reading, but it is impossible to take it seriously. For example, when a writer, professing to deal scientifically with his subject, brackets together the Moa and our domestic fowl—a Ratite bird with a Carinate—as "one species alone of living things," there is an end to any attempt at rational discussion. Mr. Coleman Phillips, in this paper, admits that he has not yet finished reading Darwin's "Origin of Species," but says, "What I have read has filled me with pain," and he proceeds to treat in a slighting spirit a book which, in the vigorous language of Professor Newton, "has effected the greatest revolution of human thought in this or perhaps in any other century."* For my own part, I regret, as well for the author's sake as for the credit of the Society, that such a paper was allowed to appear in the "Transactions." With these introductory remarks, for clearing the ground as it were, I shall proceed to discuss the subject which I have selected for my theme this evening.

The ornithology of New Zealand, apart from its intrinsic interest, presents to the thoughtful naturalist several aspects of great philosophical significance. Not the least of these is that of the many peculiar forms which it contains, and their local distribution, because of the remarkable evidence hereby furnished in support of the now generally accepted Darwinian theory of the creation of species in the organic world—that is

---

* "The theory of evolution was started as an hypothesis by Buffon, and defended and modified by Lamarck and others, but was regarded by most scientific men as a wild dream, until Darwin and Wallace, after years of patient accumulation of materials, overwhelmed the learned world with such a vast array of facts that with scarcely an exception scientific men acknowledged their defeat, and the hypothesis of evolution was raised to the rank of a theory as firmly based on facts as Newton's theory of gravitation, or the undulatory theory of light. . . . . The great charm of Darwin's theory of natural selection is its simplicity. The theory of evolution by descent with modification had a great deal to recommend it; but the difficulty always presented itself, By what possible machinery could it be worked? To suppose a special creation of every species was bad enough, and looked weak, as if the clock always wanted mending or altering to make it go right. But to suppose not precisely a special creation, but a special interference, in a given direction, with the law of *like producing like*, at every generation, was a thousand times worse; and, consequently, of two evils scientific men chose the least, and the theory of evolution was laid on the shelf until Charles Darwin and Wallace took it down again. The fact of the survival of the fittest in the struggle for existence is such a simple theory that a child can understand it; and not only the scientific world, but almost every educated man, accepted the new theory of evolution as soon as they saw—or thought they saw—the simplicity of the machinery by which it is worked."—*Seebohm.*

to say, by a natural and gradual modification of character, due to the survival of the fittest in the universal struggle for existence.

The principle of natural selection is expressed by Darwin himself as that of "the preservation during the battle of life of varieties which possess any advantages in structure, constitution, or instinct." He says, and with great force, "In scientific investigations it is permitted to invent any hypothesis, and if it explains various large and independent masses of facts it rises to the rank of a well-grounded theory. . . . If the principle of natural selection does explain these and other large bodies of facts, it ought to be received. On the ordinary view of each species having been independently created we gain no scientific explanation of any one of these facts. We can only say that it has so pleased the Creator to command that the past and present inhabitants of the world should appear in a certain order and in certain areas; that He has impressed on them the most extraordinary resemblances, and has classed them in groups subordinate to groups. But by such statements we gain no new knowledge; we do not connect together facts and laws; we explain nothing."* In his "Origin of Species" Mr. Darwin has shown that all organic beings, without exception, tend to increase at a very high ratio, and that the inevitable result is an ever-recurrent struggle for existence, in the natural course of which the strongest ultimately prevail and the weakest fail. By this process those variations, however slight, which are favourable are preserved or selected, and those which are unfavourable are destroyed. This continued production of new forms through natural selection inevitably leads to the extermination of the older and less improved forms, these latter being necessarily intermediate in structure, as well as in descent, between the last-produced forms and their original parent species. The position to which this brings us is thus stated: "Now, if we suppose a species to produce two or more varieties, and these in the course of time to produce other varieties, the principle of good being derived from diversification of structure will generally lead to the preservation of the most divergent varieties; thus the lesser differences characteristic of varieties come to be augmented into the greater differences characteristic of species, and, by the extermination of the older intermediate forms, new species end by being distinctly defined objects. Thus, also, we shall see how it is that organic beings can be classed by what is called a natural method in distinct groups—species under genera, and genera

* "The Variations of Animals and Plants under Domestication," 2nd ed., vol. i., page 9.

under families." Following the subject up with consummate skill, and bringing together a marvellous array of facts and observations, Darwin has shown very conclusively that descent with modification has been from time immemorial the means, whether naturally or artificially it matters not, of producing new and distinct forms of animal and vegetable life. The subject is on the face of it a very attractive one, and, when we come to deal with the actual facts, there is room for almost endless speculation in all directions. But what I propose to do this evening is to single out some well-established features and peculiarities of the New Zealand avifauna, to which, as you are aware, I have for many years given special attention, and to consider their direct bearing on the theory of evolution, or, putting it the other way about, to endeavour to find in the Darwinian doctrine of natural development their true and rational explanation.

Perhaps there is no country in the world where the process of natural selection among birds has had so favourable a field for its operation as New Zealand, owing to its great age as a continental island, and to the entire absence of natural enemies, up to the time, at any rate, of its occupation by man and the introduction of domestic animals which afterwards became feral. As a result, what do we find here as representing the ancient order of Ratite birds? I will not refer at present to the Moa and its kindred, because these birds have become extinct, and, except by way of analogy, do not come into my present subject. But look at the genus Apteryx, taking, for illustration, the eldest known member of the genus, *A. australis*. Here is a bird with, so to speak, the body of a turkey and the wings of a sparrow, these limbs having become so dwarfed by the operation of natural laws that they are reduced to mere rudiments; yet all the muscular parts, aborted and atrophied though they be, become perfectly distinct under the dissecting knife. Unlike all other known birds, instead of having the nostrils placed in the nasal groove, or on the ridge of the bill (as in the Petrel family), they are situated under a terminal protuberance at the extreme end of the upper mandible; and on examination it is seen that the produced upper mandible is in reality a prolongation of the facial bones—the result, no doubt, of long-continued gradual development in that direction—the brain being pushed back, as it were, into a remarkably small cranial pan for the size of the bird. These modifications of structure are of course adaptations to the feeding habits of the bird, which subsists principally on earthworms, in search of which, aided by its power of smell, it probes the soft ground or loose vegetable mould in its forest haunts. In addition to this the head is furnished with long rictal hairs or feelers, as sensitive as the

whiskers of a cat, and its hearing is known to be marvellously acute.

Mr. A. R. Wallace, in his admirable work on "Darwinism," says (at page 114), "So soon, however, as we approach the higher and more fully developed groups, we see indications of the often-repeated extinction of lower by higher forms. This is shown by the great gaps that separate the mammalia, birds, reptiles, and fishes from each other; whilst the lowest forms of each are always few in number and confined to limited areas. Such are the lowest mammals—the Echidna and Ornithorhynchus of Australia; the lowest birds—the Apteryx of New Zealand and the cassowaries of the New Guinea region; while the lowest fish—the Amphioxus or lancelet—is completely isolated, and has apparently survived only by its habit of burrowing in the sand. The great distinctness of the carnivora, ruminants, rodents, whales, bats, and other orders of mammalia; of the accipitres, pigeons, and parrots, among birds; and of the beetles, bees, flies, and moths, among insects, all indicate an enormous amount of extinction among the comparatively low forms by which, on any theory of evolution, these higher and more specialized groups must have been preceded."

Now, whilst accepting Mr. Wallace's general argument and admitting its soundness, I must venture to differ entirely with that distinguished scientist as to the position assigned to the genus Apteryx. I cannot for a moment admit that the Kiwi is one of the lowest birds in the sense implied. It rather seems to me to be an extremely specialized form, and one to which Mr. Wallace's own felicitous remarks (at page 105) are specially applicable: "In species which have a wide range the struggle for existence will often cause some individuals or groups of individuals to adopt new habits in order to seize upon vacant places in nature where the struggle is less severe. Some, living among extensive marshes, may adopt a more aquatic mode of life; others, living where forests abound, may become more arboreal. In either case we cannot doubt that the changes of structure needed to adapt them to their new habits would soon be brought about, because we know that variations in all the external organs and all their separate parts are very abundant and are also considerable in amount. That such divergence of character has actually occurred we have some direct evidence." By way of illustration, Mr. Wallace reminds us that Madeira, like many other oceanic islands in the temperate zone, is much exposed to sudden gusts of wind, and that, as most of the fertile land is on the coast, insects which flew much would be very liable to be blown out to sea and lost. Year after year, therefore, those individuals which had shorter wings, or

which used them least, were preserved; till in process of time, as we now see, the insects of Madeira have become wingless and terrestrial, or, if they have not entirely lost their wings, have had them so reduced as to be useless for flight. To my mind it would not be right to confound these wingless insects with the lower forms of the "more generalized ancestors," but rather to assign them a place among the "higher and more specialized groups." For it must be borne in mind that, as Mr. Wallace himself expresses it (page 120), the "remarkable advance in the higher and larger groups does not imply any universal law of progress in organization, because we have at the same time numerous examples of the persistence of lowly-organized forms, and also of absolute degradation or degeneration. Serpents, for example, have been developed from some lizard-like type which has lost its limbs; and though this loss has enabled them to occupy fresh places in nature, and to increase and flourish to a marvellous extent, yet it must be considered to be a retrogression rather than an advance in organization. The same remark will apply to the Whale tribe among mammals; to the blind amphibia and insects of the great caverns; and among plants to the numerous cases in which flowers, once specially adapted to be fertilized by insects, have lost their gay corollas and their special adaptations, and have become degraded into wind-fertilized forms." But it seems to me that on this point Mr. Wallace is inconsistent with himself; because at page 481, after referring to my figure of the wing in vol. iii. of our "Transactions," he says, "Even in the Apteryx, the minute external wing bears a series of nearly twenty stiff quill-like feathers"; and he goes on to say, "These facts render it almost certain that the Struthious birds do not owe their imperfect wings to a direct evolution from a reptilian type, but to a retrograde development from some low form of winged birds, analogous to that which has produced the dodo and the solitaire from the more pronounced pigeon-type." He adds that our best anatomists agree that both Dinornis and Apteryx are more nearly allied to the cassowaries and emus than to the ostriches and rheas.* Now, from this point of view, I think the language in which I long ago characterized the Kiwi—although challenged by Professor Hutton and others—is fully justified—namely, that it is the diminutive and degenerate representative of the ancient colossal forms of wingless birds.

* At page 416, *op. cit.*, Mr. Wallace says, "Whales, like Moas and Cassowaries, carry us back to a remote past, of whose conditions we know too little for safe speculation. We are quite ignorant of the ancestral forms of either of these groups, and are therefore without the materials needful for determining the steps by which the change took place, or the causes which brought it about."

Its very existence, as we now find it, is an illustration of the truth, as formulated by Wallace himself, that "greater swiftness, increased cunning, nocturnal habits, change of colour, or the power of climbing trees and living for a time on their foliage or fruit, may be the means adopted by different species to bring themselves into harmony with the new conditions; and by the continued survival of those individuals only which varied sufficiently in the right direction the necessary modifications of structure or of function would be brought about, just as surely as man has been able to breed the greyhound to hunt by sight and the foxhound by scent, or has produced from the same wild plant such distinct forms as the cauliflower and the Brussels sprouts."

I have referred to certain superficial characters; and for the purposes of our argument we need not at present go beyond these. The *Apteryx* then, I take, to be the most specialized type of its kind—an extreme form of degeneracy, using that term in its Darwinian sense. But, besides *Apteryx australis*, there are five other species, more or less distinct the one from the other, but all closely allied in every respect, size and colour being the only distinguishing characters. I will enumerate these species, with the ascertained range of each. *Apteryx australis*, already mentioned, inhabits the southernmost parts of the South Island; *Apteryx mantelli* (=*A. bulleri*, Sharpe) is spread over the North Island; *Apteryx oweni* (Gould) is met with in the wooded country in the northern and eastern portions of the South Island; *Apteryx haasti* (Potts) in the Heaphy Ranges and further south; *Apteryx occidentalis* (Rothschild) on the western slopes of the Southern Alps, and, curiously enough, in the Tararua Ranges on the west coast of the North Island; and, lastly, *Apteryx lawryi* (Rothschild) on Stewart Island.* The dividing-lines be-

* This is the same as *Apteryx maxima* of my paper (Trans. N.Z. Inst., vol. xxiv., pp. 91, 92). Mr. Walter Rothschild, in his revision of the genus (*Ibis*, 1893, pp. 573–576), says, "*Apteryx maximus* is almost a fictitious species, though I am inclined to agree with Professor Hutton that it was only an overgrown *A. haasti*. The name was published originally, without a description, by Bonaparte in the 'Comptes Rendus,' xliii., p. 841, taken from an unpublished manuscript of Jules Verreaux, and then Professor Hutton described a foot in his 'Catalogue of the Birds of New Zealand' and ascribed it to this species. Both references, however, distinctly refer to a bird from the *South Island*. In 1890 Sir Walter Buller finally announced that he had discovered the true *A. maximus* on Stewart Island, and I am fortunate in possessing the entire series from his collection; but I most emphatically say that this species cannot be *A. maximus* of Verreaux, and therefore I have much pleasure in naming it *Apteryx lawryi*, after Sir W. Lawry Buller. Sir W. Buller fully described this bird before the Wellington Scientific Society. All that I shall add is, therefore, that, though the differences between it and *A.*

tween these species, at certain points, are so indeterminate that ornithologists are not yet agreed as to how many independent species should be recognised. Dr. Otto Finsch, the well-known German scientist, contends that the North Island bird cannot be separated from *Apteryx australis*, except as a local variety, although in this view he now stands alone; Professor Newton, whose opinion always carries great weight with me, declares his inability to distinguish the former as a species distinct from *Apteryx lawryi* of Stewart Island, although he recognises *Apteryx australis*, which occupies an intermediate range of country. But the Professor is also in some doubt as to the propriety of admitting *Apteryx haasti* as a species.

Mr. Walter Rothschild, who owns the largest collection of Apteryges in the world (some thirty living birds, and I believe over a hundred skins), has, after mature consideration, decided to separate the spotted grey Kiwis into two species—*Apteryx oweni* (Gould) and *Apteryx occidentalis* (Roths.). Of the latter he possesses a living example, obtained in the neighbourhood of Milford Sound, nearly as large as *Apteryx haasti* and very different in appearance from *Apteryx oweni*, having banded plumage, a dark head, and blackish-grey feet. To this he refers Mr. Morgan Carkeek's example from the Tararua Ranges (North Island), and a number of specimens collected by different persons on the west coast of the South Island. Of the distinctness of his type I have no doubt whatever; but I am not quite prepared to follow him in uniting the others with it. They seem to me to be a form intermediate between it and the Little Grey Kiwi (*Apteryx oweni*) with which we are all so familiar. Here, in fact, we have an instance of the boundary-line between one supposed species and another being so indistinct as to occasion constant doubt and confusion in the discrimination of the forms.

Then, again, with regard to *Apteryx mantelli*, in the North Island. You are no doubt familiar with the chestnut-brown Kiwi which inhabits the Pirongia Ranges and is found all the

---

australis are very slight, they are apparently constant, owing, no doubt, to the isolation of the species."

Mr. Rothschild declines to adopt Dr. Sharpe's proposed name of *Apteryx bulleri* for the North Island Kiwi, on the ground that the bird originally named *Apteryx mantelli* by Mr. Bartlett came from the North Island, which fact, in his opinion, "establishes, without a doubt, the priority of Mr. Bartlett's name." He says, further, "As regards *A. mantelli*, I can only point out that Dr. Otto Finsch maintained that Mr. Bartlett's diagnosis was founded on a false basis, and he, moreover, believed that the North Island *Apteryx* was barely worthy of sub-specific rank. Sir Walter Buller, however, and all other ornithologists who have expressed any opinion on the subject, maintain, and, I am convinced, rightly, that the North Island bird is distinct from *A. australis*."

way down the west coast to Wanganui. But all the specimens I have seen from the east coast are almost black in plumage, even the feet being blackish instead of whitish-brown as in the ordinary bird. So far no attempt has been made to raise this form to the rank of a species, or even of a sub-species; but the fact remains that the birds from this part of the country are always dark-coloured, and, as such, readily distinguishable from the common Kiwi. And, as I have mentioned in my "Birds of New Zealand" (vol. ii., p. 310), there is likewise a rufous-coloured form, with plumage of a very peculiar texture ("Kiwi-kura" of the Maoris), which I found breeding true in the Pirongia Ranges; but, as this bird inhabits the same district as *Apteryx mantelli*, it can only be regarded as a variety. Nevertheless it shows very clearly the latent tendency to vary.

Apteryx lawryi is the largest of these species, as *Apteryx haasti* (which is next in size) is the most handsome, owing to its chestnut-and-brown dappled plumage. *Apteryx lawryi* runs as it were in parallel lines with *Apteryx mantelli* and *Apteryx australis*, as *Apteryx haasti* does with *Apteryx oweni* and *Apteryx occidentalis*. But, whether all these species be accepted as distinct, or some of them be regarded as mere varieties of others (which will always be debatable ground), there can be no doubt whatever that they have all come from a common parent stock, and that within a period of time, geologically speaking, comparatively recent. Going back to earlier times, and reasoning by analogy, we may venture to infer that the remote ancestor of the degenerate parent form was a volant bird—probably one tolerably well furnished with wings and tail, with a proportionately large head and short bill, with the muscles of the posterior limbs far less developed than in the Kiwi, and with very different plumage, both as to form and texture.

It may be asked how it is that we find the Kiwi developing a long stiletto-like bill, whilst another race of wingless birds, the Moas, belonging to the same order and inhabiting the same country, were perfecting themselves in an entirely opposite direction. But it must be remembered that, according to the ascertained laws of variation, divergence of character in opposite directions may take place even among members of one and the same species, at one and the same time, and within the same geographical area. Isolation, for such a purpose, does not necessarily mean insulation, as some writers appear to assume. Wallace puts it very clearly: "Isolation will often be produced in a continuous area whenever a species becomes modified in accordance with varied conditions or diverging habits. For example, a wide-ranging species may, in the northern or colder part of its area, become modified in one

direction, and in the southern part in another direction; and, though for a long time an intermediate form may continue to exist in the intervening area, this will be likely soon to die out, both because its numbers will be small, and it will be more or less pressed upon in varying seasons by the modified varieties, each better able to endure extremes of climate. So, when one portion of a terrestrial species takes to a more arboreal or to a more aquatic mode of life, the change of habit itself leads to the isolation of each portion."

Now, it is not difficult to imagine that in the case of a country which was gradually emerging from the depths of the ocean, presenting for long-continued periods of time low flats more or less covered with scrubby vegetation, available for purposes of concealment, a smaller size would be beneficial to the already practically wingless birds, the more so if correlated with a longer bill, for the purpose of hunting for annelids and insects in the increasing deposits of mould covering these newly-formed flats. And, bearing in mind that natural selection acts solely "by the preservation of useful variations, or those which are beneficial to the organism under the conditions to which it is exposed," we should in this case regard the so-called degeneration of the Kiwi as an improvement in the organism of the bird in relation to its conditions and environment. So also, in regard to those wingless birds which continued to inhabit the table-lands, and to subsist on fern-roots and the ever-present "cabbage-tree," should we regard a longer neck and a stronger bill as beneficial variations, especially if correlated with a more massive posterior development, such as that which distinguishes *Dinornis elephantopus* and *Dinornis crassus*. May not the giant Kiwi (*Megalapteryx hectori*), the remains of which were discovered and described by the late Sir Julius von Haast, represent one of the intermediate forms which have been stamped out and lost in the long-continued struggle for existence along the borderland, so to speak, of these different races of wingless birds?

As I have already stated, each so-called species of Kiwi is restricted in its range to a particular district. In the case of *Apteryx mantelli* and *Apteryx lawryi* this is insular, save as to the appearance of the Grey Kiwi on the Tararua Range, which I shall presently endeavour to account for. Now, if any sudden catastrophe were to overtake New Zealand, destroying all animal life, the remains of the different species of Kiwi (so far as they could be distinguished) would be found in different localities and never commingled. This is not the case with Dinornis and its allies. The bones of about a thousand birds were exhumed by Sir Julius von Haast from the Glenmark marshes, and these comprised the skeletons of several

genera and numerous species, varying considerably in stature, all mixed up indiscriminately together, showing that these birds had inhabited the plains of Canterbury at one and the same time. I have endeavoured to furnish an explanation of this in my introduction to "The Birds of New Zealand," pages xxxiv., xxxv. Adopting a theory first put forward by Professor Hutton—to whom I acknowledge my indebtedness—I have attempted to show how this could have been brought about by natural causes. By going much further back in time—and that is the charm of the evolution theory, that it imposes practically no limits as to time and space—I have supposed that in very ancient times two or more species of brevipennate birds, themselves the descendants of volant birds of a still earlier epoch, roamed over a great southern continent, which, by some convulsion of nature, was afterwards submerged, leaving its higher levels and mountain-tops exposed in the form of numerous scattered islands, on which the survivors of the wingless race of birds would naturally remain; that this state of things continued long enough—how long it is impossible even to conjecture—for the inhabitants of each island to develope new characters suited to their special environment in each case, thus bringing into existence in the end the various species of Dinornis and its allies as we now know them; that a widespread upheaval or elevation of the land followed, reuniting most of the islands, and resulting in the areas now known to us as the Islands of New Zealand, when, of course, the Struthious birds which had been developed in the smaller insular areas would be able, in process of time, to commingle on common ground. "In process of time," I say, because it would naturally take a considerable time for the newly-elevated areas to become covered with vegetation, although, on the other hand, it is quite possible that this elevation may have been gradual in its operation everywhere. I suggested that when, by the gradual subsidence of their domain beneath the waters of the great Pacific, they were driven as it were into a corner and overcrowded, the struggle for existence became a severe one, and the extinction of the race then commenced; that the more unwieldy giants, thus cabined and confined, were the first to succumb; and that the smaller species, perhaps in course of time differentiated from their ancestors by the altered physical conditions of their environment, continued to live on till their final extirpation by man within recent historic times. Professor Hutton supposes two successive submergences and elevations of the land at long intervals, but in this I am unable to follow him. Without that, the theory is sufficient, I think, to account for the co-existence in comparatively recent times of the various genera and species. But, as the modifications in form and

structure constitute important generic distinctions, very long periods of time must have elapsed after the continental submergence before the final elevation of the land which made it possible for these wingless birds to commingle as they evidently did in later times. On the assumption that the North and South Islands were never reunited after the great submergence, these two areas having been independently formed by the fusion of different sets of islands, north and south, when the elevation took place, this theory will account for the singular fact that the Dinornis remains found in the North Island represent different species of birds from those of which remains have been so abundantly discovered in the South.

Professor Hutton is of opinion that the smaller forms of Ratitæ in New Zealand must have preceded the larger; and the fact that bones of only the smaller species of *Dinornis* and *Syornis* have as yet been found in both Islands seems to favour that view. But the evidence on this point is, I think, far from being exhausted, for fresh discoveries of Moa-bones are still being made from time to time, and in the most unlikely localities. On the other hand, whatever date may be assigned for the extinction of the Moa (and upon this question there is much difference of opinion), there seems little doubt that the colossal forms, such as *Dinornis maximus*, *D. altus*, *D. validus*, and *D. excelsus*, were the first to become extinct, because none of their remains have ever yet been found in the ancient kitchen-middens, mixed up with the rejectamenta of human feasts, or bearing evidence by chipping or gnawing of manipulation by man in a recent state; besides which they have sometimes been found in a highly fossilized or mineralized condition, unlike the bones of the smaller species, which contain much organic matter and often look perfectly fresh. I am of opinion that the larger forms are the more ancient, and are those that roamed originally over the afterwards submerged continent, and that the smaller-sized Moas, of different genera and species, are the descendants of those which had been specialized in the various islands during the long epoch following the continental submergence. Professor Hutton, accepting the outcome of Professor Parker's important researches into the embryology of this form, admits that in the Kiwi the hind limbs undergo a relative diminution in size between the time of hatching and the attainment of fully adult proportions, especially in the case of the female; and he adds, "This implies that the ancestral Kiwis were, like *Megalapteryx*, larger than the living birds; and we may infer the same thing from the great size of the egg. It is a legacy from a larger bird which is not easy to get rid of. The greater proportionate size of the female is probably due to its having to lay such a very large egg. The males have decreased in

size more rapidly than the females, who were handicapped by such large eggs." Professor Hutton suggests that the reverse of this obtained in the case of the Moas; but there is no evidence of that. After a critical examination of all the evidence afforded by the bones and their distribution, he says, "Evidently *Anomalopteryx* and *Palapteryx* are the oldest forms; but if *Palapteryx* had wings it could not have been derived from the wingless *Anomalopteryx;* and, if the birds were increasing in size, *Anomalopteryx* could not have been derived from *Palapteryx*."* Exactly so; but on my hypothesis these difficulties disappear, and the supposed conditions are in harmony with it. In this connection I may mention the curious fact that, although *Anomalopteryx didiformis* is one of the smallest of the Moas, scarcely exceeding in size the common Bustard, it had proportionately the largest skull of all the *Dinornithidæ*. Commenting on this, Professor Owen remarks that, if the peculiarly nutritious roots of the common fern contributed, together with buds or foliage of trees, to the food of the various species of Moa, the concomitant gain of power in the locomotive and fossorial limbs does not appear to have called for a proportionate growth or development of brain or of bill.

As with the Kiwi, it would seem that the development of the Moa was downwards, or in the way of degeneration, and the restriction of its range to small insular areas would doubtless favour this dwarfing process.

One can understand how in process of time the various species of Kiwi now known to us have become evolved from the parent stock by means of natural selection and the survival of the fittest, operating under well-established natural laws. Any divergences of character, however small to begin with, long continued and persisted in, would account for any number of so-called species in various parts of the country. For, a species—what is it? What does the name denote? Of what use is it to science except as an artificial definition, and for the greater convenience of systematic classification?

But the great difficulty in any theory on the subject is to account for the presence of the Grey Kiwi on the west coast of both Islands. Our knowledge of its existence in the North Island rests on a skin brought to me in a fresh state by Mr. Morgan Carkeek, who obtained it just below the snow-line on the highest of the Tararua Ranges, where, he states, he could have collected many more. For the present, I confess that the presence of this species in the North Island is very perplexing. One solution that suggests itself to my mind is that it may

* "On the Moas of New Zealand," by Captain F. W. Hutton, F.R.S., Trans. N.Z. Inst., vol. xxiv., p. 149.

have been introduced in former times through human agency. It will be remembered that the Maoris have a tradition that the Pukeko, or Swamp-hen (*Porphyrio melanonotus*)—which, until recent years, when its haunts were invaded and drained, was excessively abundant in both Islands—was first introduced by their ancestors, who brought tame birds with them in their canoes from Hawaiki. It must be borne in mind also that the range of the Grey Kiwi includes the north-west coast of the Nelson District, for specimens which I obtained from that locality have been referred by Mr. Rothschild to his *Apteryx occidentalis;* and, furthermore, that the passage to and from the Kapiti coast, on the opposite side of Cook Strait, could easily be effected by the Maoris in their war-canoes. To entrap a few Kiwis, and bring them across alive in flax cages, would have been a very simple operation, and a far less ambitious project than that of stocking New Zealand with the Swamp-hen from far-off Hawaiki. The suggestion does not seem an unlikely one, when we remember that the Kiwi was always highly prized by the Maoris from the earliest times, both as an article of food and on account of its feathers.

On the theory put forward, and assuming, as we fairly may do, that the North and South Islands have never been united since the continental submergence,—in other words, that there was a simultaneous elevation of the two areas, north and south, with a permanent sea-channel dividing them,—we can understand and account for the existence of closely-allied representative species in the two Islands. I will give some examples: In the North Island the Blue-wattled Crow (*Glaucopis wilsoni*), in the South the Yellow-wattled Crow (*Glaucopis cinerea*); in the North Island the Saddle-back (*Creadion carunculatus*), and in the South its grey ally, *Creadion cinereus*. It is true that *Creadion carunculatus* is found also in the South Island, which is the proper home of *Creadion cinereus*. This may, I think, be accounted for by an accidental colonization at some time, through the crossing of stray individuals to the other side of the Straits: even a single pair would suffice. Rare as this bird now is along the wooded shore on the north side of Cook Strait, I can remember that about thirty-five years ago it was more abundant there than in any other part of the country. But to resume my list of examples: In the North Island we have the Thick-billed Thrush (*Turnagra hectori*), in the South the common *Turnagra crassirostris;* in the North Island the Wood-robin (*Miro longipes*), in the South its congener *Miro australis;* in the North Island the Whitehead (*Clitonyx albicapilla*), in the South the Yellowhead (*Clitonyx ochrocephala*); in the North Island the White-breasted Tomtit (*Myiomoira toitoi*), in the South the Yellow-breasted Tomtit (*Myiomoira macro-*

cephala); in the North Island the Pied Fantail (*Rhipidura flabellifera*), in the South the Black Fantail (*Rhipidura fuliginosa*). The same remark applies to the former of these as to the Saddleback, and the same explanatiom may be offered. It will, perhaps, be objected that this bird is too weak-winged to cross the Straits under any circumstances; but, as against this, I may mention that during the past twenty years there have been several well-authenticated cases (as recorded in my "Birds of New Zealand") of the Black Fantail crossing the Straits to the North Island; and of late years there has not been wanting evidence of its breeding here. What, therefore, is there to prevent such a species becoming naturalized in the North Island, and that without the intervention of any but natural causes? A gale of wind, under favourable conditions for the passage of the Straits, would alone be sufficient to occasion this dispersal of the species.

Now, all the representative forms I have named are accepted by ornithologists in general as good and true species. But take any two of them and compare them carefully. Who can for a moment doubt their common parentage?—how far back in time, it is not our present purpose to inquire. "Species," "sub-species," and "varieties" are now terms in general use among ornithologists, as well as among other specialists, and, as it seems to me, simply for the purpose of indicating the distinctness or otherwise of the lines of demarcation separating one from another in their present stages of development under the slow and invisible, but nevertheless inevitable and sure, processes of that law of evolution which governs the whole animal kingdom. When we come to study the matter more closely it often seems well-nigh impossible to draw any specific line at all. So-called species often appear to run into one another by insensible gradations; so much so, indeed, that no two naturalists are agreed as to how much persistent difference is necessary to constitute a species, as distinguished from a sub-species or variety. Take, by way of illustration, the various forms of Woodhen (*Ocydromus*) inhabiting New Zealand. Dr. Bowdler Sharpe, who, as a rule, does not err on the side of "lumping," has recently declared (Bulletin, 1893, p. xxx.), that he finds it impossible to distinguish *Ocydromus greyi* of the North Island from *Ocydromus earli* of the South Island. This difficulty arose, no doubt, from the circumstance of his examination of the two forms having been confined to dried specimens. If he had been permitted to study the live birds he would have seen that, apart from the unmistakable difference in the general hue of the plumage, *Ocydromus greyi* has brown irides and legs, whereas the southern form (*Ocydromus earli*) has these soft parts of a lake-red colour. He says further (*loc. cit.*, p. xxix.) that he

prefers the simple arrangement in my first edition of "The Birds of New Zealand," limiting the number of species to three, to that of my second edition, fifteen years later, which admits five species of the group. This alteration, however, was not made by me hastily or without full consideration. I believe I have critically examined a very much larger number of *Ocydromi* than any other working ornithologist, and, although I do not wish to underrate the perplexities presented by the intergrading of plumage, I think I have adopted a very cautious rule of admission. Professor Hutton has recognised at least two more—namely, *Ocydromus hectori* and *O. finschi*—and a naturalist given to what is termed "splitting" might easily have increased the number still further. But this is the *crux* of the whole thing. In this particular instance the species of one naturalist is the subspecies of another, and the "local variety" of a third. What is this but the existence of transitional forms under the steady march of evolution?

But the question of the great variability of the South Island Woodhens opens up a larger one, which I confess myself quite unable to answer. How is it that in the North Island there is but one well-marked species of Woodhen spread over its entire area, whilst in the South Island, under practically the same conditions of environment, there are at least four species, and possibly more, running into one another in such a way as to puzzle even the most expert ornithologists?

The Woodhen genus offers an exceptionally good example for a study of this sort, because, although furnished with ample wings, the quills are soft and useless, and the birds in consequence are flightless.

To take another instance of the kind: the Kakapo or Ground-parrot (*Stringops habroptilus*) has ample wings, and yet it is incapable of flight. The presence of this flightless bird, essentially the same in all respects, in both Islands, presents a difficulty which cannot be ignored. But, then, some species are more persistent in their character than others; and it may be that the Kakapo, as it existed in different areas before the final elevation, had reached its full development, and has remained stationary ever since. Its markings had become so exactly like the green mosses and other vegetation among which it feeds, thus effectually protecting it from birds of prey, and, in the absence of feral animals, the faculty of flight had become so unnecessary to it, that it is difficult to see in what direction natural selection could operate further to the advantage of the bird. It may be asked why, seeing that the Kakapo is flightless from long disuse of its wings, these members have not been more completely aborted,

or dwarfed to mere rudiments, as in the case of the Kiwi. The obvious answer is that, allowing the necessary time,—in how many generations it is impossible to say,—the same results would naturally come about. How long it may have taken for the Kiwi to become practically wingless since the process of degeneration commenced we have no means of even guessing. But our pestilent civilization has, of course, put a stop to all that, and within measurable time the Kakapo will disappear altogether,—passing out of existence, in full possession of its wings, but feeble in their quills, and crippled by the atrophy of their muscular mechanism.*

This incidental reference to the Kakapo and its protective colouring leads me into another very interesting field of observation — namely, the gradual adaptation, by natural selection of course, of certain species to their habitual environment by the acquisition of protective colours. The olive-green Bell-bird is almost invisible to the eye as it clings to the leafy climbing tawhiwhi (*Metrosideros scandens*), and inserts its brush-tongue into the corolla of the crimson flower; the grey-and-white Ground-pipit eludes the most practised eye as it perches on a dry log, or nestles by the wayside; the Bronze-winged Cuckoo so harmonizes with its surroundings as it rests silently on a low bough that you may be within a yard of it without detecting its presence; the Dottrel and the Godwit squat on the sands without being seen; the Wry-billed Plover hides itself among the loose pebbles and shingles of its own grey colour; the green Parrakeets are undistinguishable from the bright evergreen vegetation among which they feed; the Kaka, but for its discordant cry, would generally be safe from observation in the midst of the brown branches among which it loves to climb and explore for insects; the Rifleman, the smallest of our native birds, is quite invisible as it clings to the lichen-covered bark; and the Bush-wren hops in safety among the moss and vegetation of the forest to which its own colours so closely assimilate. And so one might go on selecting examples almost without end, in illustration of the well-known law to which I have referred as being almost universal in its application and effects.

Leaving birds, however, for one moment, let us consider the remarkable correlation of colour with its surroundings in

---

* I think there is a manifest advantage in questions of this kind being investigated and discussed by ourselves on the spot. In illustration of this I may refer to a very curious mistake made by Mr. Alfred Russel Wallace, the great apostle of the creed of natural selection,—to whom, indeed, we all metaphorically doff our hats in respectful admiration. In writing of the New Zealand avifauna he confounds the Kakapo with the Kea, declaring that the moss-eating *Stringops* had become carnivorous, and is most destructive to the settlers' sheep!

the case of many of our lizards. The beautiful green lizard (*Naultinus elegans*) so exactly harmonizes with the manuka bushes on which it is usually found that it requires a very practised eye to distinguish it. The protective resemblance is rendered more complete by the leaf-shaped markings of yellow on the back and sides; and it is pretty clear that this particular character has been acquired by natural selection, or descent with modification for protective purposes, inasmuch as the young of this species is of a uniform green colour. These remarks apply with even stronger force to my *Naultinus pulcherrimus*, from Nelson, although, being a somewhat rare species, it is perhaps less noticeable. Here the irregular white markings, intermingled with the yellow and green, coupled with the animal's peculiar habit of curling up its tail in the form of a "Catherine's wheel," render the deception absolutely perfect. In this case also the young is of an almost uniform green colour, varied only with leaf-like markings of a darker green on the back. Then, again, as I have previously pointed out, the markings on the back of my *Naultinus sylvestris* (discovered by Mr. Annabell at Wanganui) so exactly resemble the minute yellow lichens which cover stems of dead wood in the forests as to render it at all times perfectly safe from detection in such situations. *Naultinus sulphureus* —whether we regard it as a distinct species or only a pronounced local variety—is admirably adapted by its uniform yellow colour to the sulphur deposits of Rotorua, where alone it has been met with. But to come to the common species: where could we find a more beautiful adaptation of colouring to the natural surroundings than in the case of our common tree-lizard (*Naultinus pacificus*), the shades and markings of which present an almost endless variety; or in that of the variable *Mocoa ornata* and *Mocoa zealandica*, inhabiting our stony places and roadside vegetation? A case even more remarkable still is that of our wonderful *Sphenodon punctatum* or Tuatara lizard. Now this lizard is so abnormal in its character that it forms by itself a distinct order of reptilia, and exhibits the most bird-like skeleton of all existing reptiles. It is perhaps generically the oldest inhabitant of the earth, being closely allied to the *Prohatteria* of the Permian period, its nearest relations being the various forms of *Rhyncocephala* which occur in the Trias. I have not time now to refer to the wonderful peculiarities of this living representative of a remotely ancient race; but I may mention that the Tuatara has been found to possess, concealed under the tough skin of the forehead, the vestiges of a third but now obsolete eye, the functional parts being present, even to the optic nerve! It has become extinct on the mainland; and it is a very curious fact that, through long isolation, it has become differentiated

in colour in the several islands or groups of islets which it inhabits. With the exception of a green form, exhibiting some structural modifications, which I have dedicated to our great herpetologist, under the name of *Sphenodon guentheri*, it has been found impossible to distinguish these forms except as local varieties, sufficiently well marked however to admit of their being referred to their respective island habitats. What are these, I would ask, but incipient species? Allowing sufficient time under the existing conditions of life, and, reasoning by analogy, each island or group of islets must in the end possess a distinct species of *Sphenodon* exactly suited to its environment. It is, moreover, sufficiently clear that nothing but the island asylum could have saved this lowly-organized and archaic form from absolute extinction.*

Less fortunate has been another form of New Zealand lizard, the Kawekaweau, whose quasi-arboreal habits of life have prevented its taking advantage of this last refuge. From the accounts of the natives, the Kawekaweau appears to have been a form of iguana inhabiting the deep forest, and there can be no doubt that it lingered in the land till within the last thirty years, when the remnant of its race succumbed to wild pigs and other natural enemies. It is always described by the Maoris as beautifully marked with alternate

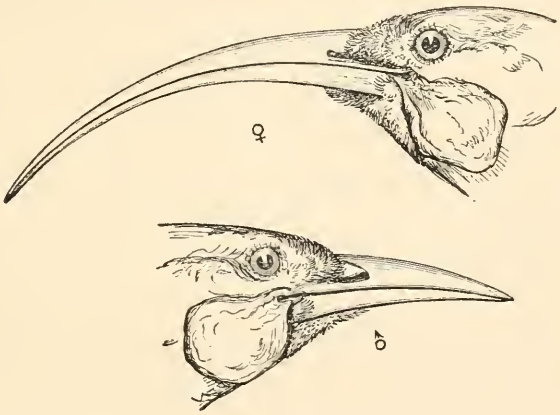
---

* I may here remark that one is surprised to find a naturalist like Mr. H. O. Forbes—fresh from New Zealand, and with all the literature on the subject at his command—in his recent address to the Royal Geographical Society, referring to the Tuatara as "a curious and ancient form of lizard now absolutely confined to an islet off the coast of the North Island." Here is a statement of fact, made with apparent scientific accuracy, and yet far wide of the truth. It is quite true that the tuatara has become extinct on the mainland, but it still exists in considerable numbers on the rocky islands adjacent to our coasts. It is common on the Hen and Chickens, on Cuvier Island, on the Poor Knights, on the Mercury Islands, and on the Barrier Islands, in the Hauraki Gulf. Coming further south, it is abundant on the Alderman Islands, on Motunau or Plate Island, on the Island of Karewa in the Bay of Plenty, on the Rurima Rocks, on Whale Island, and on East Cape Island. It inhabits the various groups of islands in Cook Straits, such as Stephen Island, the Brothers, and the Chetwynd Islands. It has been recorded from other localities; and it is highly probable that it exists on many unexplored islets or rocks lying off the coast of the North Island. The last recorded specimen from the mainland was captured in Evans Bay about the year 1842, and was preserved by Dr. Monteith, one of the early Wellington settlers. He presented it to me some twelve years later, and it is now in the collection of the Colonial Museum. The extermination of this lizard is attributed to its natural enemies of modern times, pigs and rats, whose ravages it has hitherto been able to escape on the small uninhabited islands. Unfortunately, of late years even there it has been exposed to the persecution of travelling natural-history collectors, one of whom is said to have forwarded at one time to Europe no less than three hundred specimens preserved in spirits.

bands of colour, and reaching at maturity to a length of 2ft. or more.*

But, although these are good illustrations of the correlation of colour and of the extinction of well-established forms in the struggle for existence, I feel that I am rather digressing from the real subject of my address.

Closely connected with this subject of assimilative colouring is that of the gradual adaptation of structure to the conditions of existence. In my "Birds of New Zealand" I have called attention to some remarkable cases of this kind, and notably to that of the Huia (*Heteralocha acutirostris*)—an instance quite unique in the whole class of Birds—where the sexes present differently-formed bills, specially adapted to their habits of life and general economy. Now, on what principle apart from the Darwinian theory can we explain this remarkable sexual difference?



And to mention another case, that of the Wry-billed Plover (*Anarhynchus frontalis*) is a very remarkable one. In this instance the bird has the bill turned or twisted to the right, this asymmetry being admirably adapted to this plover's peculiar mode of feeding among the pebbles of the seashore. In the case of our beautiful Red-necked Avocet (*Recurvirostra novæ-hollandiæ*), the curvature of the bill is upwards instead of sideways; and in both forms this marvellous departure

* It is significant that the Long-tailed Cuckoo (*Eudynamys taitensis*), whose streaming tail-feathers are handsomely barred in their whole length with chestnut and black, is also known by the name of Kawekaweau in many parts of the country. In like manner the name Kakariki (indicative of the colour) is applied alike to the green lizard and to the Green Parrakeet of our woods.

from the normal type of a plover's bill is congenital, being present in the unhatched embryo. Then, again, what is the Rock Wren (*Xenicus gilviventris*) but an extreme development of the Bush Wren (*Xenicus longipes*)—which has put off its green plumage for the dun-coloured dress more in harmony with its surroundings among the rocks on the open mountain, and has acquired a longer hind claw, so as to fit it for this different habitat—or *vice versâ?* The particular direction of the development does not of course affect the argument. And it is a significant circumstance that I possess intermediate forms; so much so, in fact, that I have been in doubt as to which of the two species they really belonged. Or, to take just one more case: who can doubt that the fleshy membrane on the bill of our Blue Mountain Duck (*Hymenolæmus malacorhynchus*) has been specially developed to enable it to hunt the more successfully for the peculiar stone-encased caddis-worm of our mountain streams, which now forms its principal article of food?

But now, to revert to my main line of argument: In considering the problem of representative species in the North and South Islands respectively, it must be borne in mind that there are probably many broken links in the chain of succession through the disappearance of representative forms. We all know that the existing avifauna is being stamped out and destroyed by a variety of artificial causes, not the least among them being the naturalization of foreign birds by way of acclimatization, on the one hand, and the introduction of bloodthirsty animals like stoats, weasels, and ferrets, on the other. But long before the effects of our drastic colonization made themselves felt, many of the ground species were dying out, in obedience, no doubt, to that inscrutable law of nature whereby races of animals and plants, apparently of their own accord, die out and give place to other forms of life. I remember, when I was a boy, the interest with which I followed the Maoris' descriptions of birds that had even then become rare or were disappearing from the land. One bird, a species of Rail apparently, was often mentioned to me under the name of Pukunui—so called from the abnormal size of its stomach. It was described as a reddish bird, frequenting swamps and marshes, and I was constantly hearing of it. Indeed, I never made an excursion among the Maoris anywhere without making diligent inquiry for the Pukunui, so much so that the older men thought I had Pukunui on the brain. I offered liberal rewards, and often felt that the bird was almost within my grasp. At length, at the small bush settlement of Mareikura, on the North Wairoa River, one was caught at the edge of a raupo swamp near the village by my trusty lieutenant, Tamati Nui. It had been taken unhurt,

and, pending an opportunity of forwarding it to me, it was kept tethered by a flax-string in the marae or open court-yard. A passing Maori unconsciously snapped the string with his foot, and, unfortunately for me and for science, this "*rara avis in terris*" made its escape. More than forty years have elapsed since this occurrence, and I have never so much as heard of the capture of another Pukunui!

In this connection, and also as marking the tendency towards extinction in certain lines, it is of interest to notice that the Ralline genus Notornis was contemporary with the smaller species of Moa, and that the bones of the living bird obtained in Otago differ so much from those of the fossil remains discovered by Mr. Walter Mantell at Waingongoro, in the North Island, and referred by Professor Owen to a form which he named *Notornis mantelli*, in honour of the discoverer, that Dr. A. B. Meyer, of Dresden, proposes to discriminate two species, distinguishing the southern form as *Notornis hochstetteri*, in compliment to the Austrian explorer. Assuming Dr. Meyer to be right in his determination, we have here a beautiful instance of representation, the North Island species having long since disappeared, whilst the South Island species is verging on extinction.

I think I have now noticed all the main points bearing on this question arising out of a study of the birds of the North and South Islands. But it is to the smaller insular areas that we naturally look for the strongest proofs in support of our theory, because the conditions there are altogether more favourable. Let us first take the Chatham Islands, lying about four hundred miles to the south-east of Wellington. It is very clear that there has been no land communication between the Chathams and New Zealand since the continental submergence. This has allowed time for the production by natural selection and the survival of the fittest of several distinct species. Now, let us see what we have. Notably, a new species of Bell-bird (*Anthornis melanocephala*) has come into existence—a much larger and finer species than our Korimako (*Anthornis melanura*), although presenting the same adolescent and sexual phases of plumage. But the curious thing about it is that, side by side with this endemic species, our Bell-bird is also to be found in the Chatham Islands and on the adjacent islets (Pitt Island and Mangare). To my mind the only explanation of this is the same that I have given in a former paper (Trans. N.Z. Inst., vol. xxiv., p. 65) for the occurrence side by side of *Platycercus unicolor* and *Platycercus erythrotis* on Antipodes Island—namely, that the smaller species owes its existence there to a comparatively-recent colonization, the result of some accidental flight or migration from the mainland,—with this difference: that in

the case of *Platycercus erythrotis* the irruption of the parent form must have been long anterior to the colonization, so to speak, of the Chatham Islands by the New Zealand Bell-bird, inasmuch as there has been time for a sufficient modification of characters to entitle it (in the opinion of many ornithologists) to take specific rank, distinct from *Platycercus novæ-zealandiæ*. As to such occasional migrations there would be nothing in the distance, at any rate, to negative such a supposition. Then, again, we have a Wood-pigeon (*Carpophaga chathamiensis*) very similar to the New Zealand bird, but sufficiently differentiated to be accepted as a good species. Other representative forms are the Black Robin (*Miro traversi*), the Bush Warbler (*Gerygone albofrontata*), and the Chatham Island Fern-bird (*Sphenœacus rufescens*). The near relatives of all these are to be found in New Zealand. But, instead of *Ocydromus*, there is a small flightless rail—a degenerate Ocydromine form—which Professor Hutton has made the type of a new genus, *Cabalus modestus*. To this genus (although the form is less aberrant from the typical *Rallus*) I have referred Dieffenbach's Rail, which is now extinct, the only known example being the one in the British Museum, obtained about the year 1845.

So far as we are aware no bones of *Dinornis* have yet been discovered in the Chatham Islands, but I have no doubt that they will be sooner or later; and I feel pretty sure that when discovered they will be found to be of different species (perhaps of different genera) from those known to have inhabited New Zealand in comparatively recent times: that is to say, our theory seems to require, for the sake of consistency, that this should be so, inasmuch as the same differentiation would be taking place in the Chatham Islands as in the other insular areas after the great submergence. And, as the Chatham Islands unquestionably formed part of that ancient continental area of which I have been speaking, we may reasonably expect to find there, sooner or later, fossil remains of the earlier forms (such as *Palapteryx*), similar to those that have been unearthed in the North and South Islands of New Zealand. As to the remarkable avian remains recently discovered by Mr. H. O. Forbes in the Chatham Islands, and referred by him to a genus allied to *Archæopteryx*, we may feel equally assured that similar remains exist in New Zealand, and will hereafter be found in abundance to reward the diligent explorer.

The Auckland Islands, again, offer several good examples. Among the species specially developed there may be mentioned a Ground-pipit (*Anthus aucklandicus*), very readily distinguishable from our New Zealand bird by its rather larger size and warmer colouring; and a Green Parrakeet (*Platycercus auck-*

landicus), much smaller, but in other respects similar to our *Platycercus novæ-zealandiæ*. Representing our *Rallus philippensis*, there is a very distinct species of Rail (*Rallus muelleri*, Rothschild), of which the only known specimen is in the Natural History Museum at Stuttgart; and, as if representing our *Anas chlorotis*, there is a flightless Duck (*Nesonetta aucklandica*) frequenting the seashore as well as the streams. But, what is still more significant and curious, there exists in the Auckland Islands a species of Merganser (*Mergus australis*), of which there is no representative in New Zealand, or indeed anywhere else in the Southern Hemisphere. The Bell-bird is there also, but it seems to be absolutely identical with the New Zealand form (*Anthornis melanura*), showing, as I think, a comparatively recent introduction.

On Antipodes Island, as already indicated, there is a strictly endemic Parrakeet (*Platycercus unicolor*), a species living abundantly on this oceanic rock, but not to be met with in any other part of the world, and commingling with a species (*Platycercus erythrotis*) more nearly approaching to the typical *Platycercus novæ-zealandiæ*. Going further south we come to Macquarie Island, where there is a Rail differing so perceptibly from ordinary examples of *Rallus philippensis* that Professor Hutton has proposed to distinguish it as *Rallus macquariensis;* and, although I am not prepared to concede to it distinct rank as a species, its presence there is another proof of the existence of transitional forms. It is an inexplicable fact, however, that on the same island is to be found the flightless *Ocydromus earli*, differing in no respect from examples obtained in New Zealand and on Stewart Island.*

On the Snares, a group of islets about seventy miles south of the southernmost extremity of New Zealand, there is a peculiar form of Fern-bird, which I have recently distinguished under the name of *Sphenœacus caudatus*, very similar to *Sphenœacus punctatus* of New Zealand, but quite distinct as a species, and being intermediate in character between the last-named bird and *Sphenœacus rufescens* of the Chatham Islands. Now, no ornithologist who has studied the subject can doubt that these three closely-allied forms, although now perfectly distinct as species, have sprung from a common parent-form. Curiously enough, another Chatham Island bird, the Black Robin (*Miro traversi*) is abundant on the Snares, although not found in any part of New Zealand.

* Since the above was written I have had from Captain Fairchild what seems to be a sufficient explanation of this. He states that, about the year 1830, Captain Gilroy (who is still living at the Bluff) was first mate of a small sealing vessel visiting the Macquaries, and that, in order to provide another source of food-supply, he brought a number of live Woodhens from New Zealand and turned them loose there.

Then, again, the Kermadec Islands possess a Green Parrakeet which Mr. Rothschild declares to be distinct; and, although many naturalists will insist that this and the other island forms are, for the most part, local varieties of the well-known *Platycercus novæ-zealandiæ*, their very existence as such is the best evidence of the constant operation of the law of development by variation and the survival of the fittest.

Even the sea-birds, whose range is practically unrestricted, furnish additional and, indeed, very important evidence. Mr. Rothschild, with the aid of Mr. Salvin, our great authority on the Petrel family, has lately been investigating the Albatroses of the Southern Hemisphere. Talking over the result with me, he said, "Why, every group of islands seems to have its own species of Albatros!" And, in a sense, this is true. Here we have birds enjoying the freedom of the wide ocean—commingling daily on their great hunting-fields on the face of the deep; and then, on the approach of the reproductive season, separating themselves, according to their species, and repairing to their own island-nurseries to breed. As far as our information at present goes, Campbell Island is held exclusively by my *Diomedea regia*, the noblest member of the group. The Auckland Islands are occupied by thousands of *Diomedea exulans*, with the exception of a small colony of the former breeding in a remote corner of the main island, and at a somewhat earlier season—according to Captain Fairchild's observations, four or five weeks earlier. On the Snares *Diomedea salvini* (hitherto known here as *Diomedea cauta*) reigns supreme. The Albatros breeding on the Sisters, some outlying islands in the Chatham group, on which the Maoris are said to have collected as many as a thousand young birds in one season, is probably *Diomedea melanophrys*, which is plentiful in that latitude; but I have not yet been able to obtain any specimens from that locality for identification. The breeding-place of *Diomedea bulleri*, Rothschild (hitherto confounded with *Diomedea culminata*), I have not yet discovered, all the specimens of that form known to us (some twenty in number) having been captured off the Otago coast.

Many of the smaller species of Petrel, it may be observed, confine themselves to particular islands: for example, *Puffinus carneipes* is the commonest of birds on the Island of Karewa, in the Bay of Plenty, but, so far as I am aware, has never been found breeding on any other island off our coast.

As with the Petrels, so in a limited sense with the Shags and Penguins, many of the species of both having their particular island group, which they resort to, for breeding purposes, to the exclusion of all others.

Finally I may refer to the Snipes, the local distribution of which is very remarkable indeed. My *Gallinago pusilla*,

the smallest of the Snipes, is an inhabitant of the Chatham Islands, where it is apparently very plentiful, Mr. Rothschild having, as he informs me, received from his collector, in one lot, fifty-four specimens. Sir James Hector has recorded two specimens from New Zealand, but it is evidently only a straggler with us. *Gallinago aucklandica* appears to be confined to the Auckland Islands, *Gallinago tristrami* to Antipodes Island, and *Gallinago huegeli* to the Snares. It will be seen therefore that these island-species are very sedentary; and they have no doubt acquired their distinctive characters through long isolation. Whether they are accepted by all ornithologists as true species or only as local varieties does not affect in the slightest degree the force of our argument in favour of the creation of new forms by a process of descent with modification. But I have probably pursued this branch of the subject quite far enough. There is another aspect of the question upon which I should like to say a few words before I close.

I have always stated my belief that our colossal forms of *Dinornis* were the most ancient and were the first to become extinct. Those on which the Moa-hunters feasted (as attested by the remains now found in the old kitchen-middens) were confessedly of a smaller stature. Probably the very last to disappear was the small *Mesopteryx didinus*. In 1878 Mr. Squires, of Queenstown, obtained and sent to the British Museum the head, with a continuous part of the neck, of this species of Moa, with the trachea enclosed and covered by the dried integument, and exhibiting even the sclerotic bone-ring of the dried eye-balls; also the bones of both legs with the feet covered by the dried skin, with some feathers adhering to it, and with the claws intact. Be that as it may, the only representatives of this Struthious race we have at the present day are the diminutive Kiwis, of which I have been treating. This remarkable sequence in the development of animal life on the earth, the larger forms preceding in geological time the smaller, appears to have been universal. The distinguishing feature of the Mesozoic period was the development of Saurians of marvellous size. From the Oolitic beds in the Rocky Mountains of North America the remains of huge Dinosaurians have been obtained, among these being the *Atlantosaurus*, the largest land animal yet known to have existed on the earth; for Professor Marsh describes it as "having been between 50ft. and 60ft. long, and, when standing erect, at least 30ft. high!" At the present day our largest saurians are crocodiles and alligators. But, coming down to Pliocene and Pleistocene times, we have only to think of the mammoth and the mastodon, the dinotherium and the megatherium, the diprotodon and the Irish elk, and compare them with the

elephant and the hippopotamus, the rhinoceros and the buffalo, of the present epoch, to realize the full force of this truth. But these revolutions in the animal world have, in both the Northern and the Southern Hemisphere, been accompanied by corresponding alterations on the earth's surface, and by climatic changes of a very extensive kind. To give one illustration: The mammoth was an animal which subsisted on herbage and vegetation of all kinds; and, looking to its unchecked and ever-increasing numbers, it would clearly have required a growth of tropical luxuriance to satisfy the wants of its capacious stomach. But where do we now find the remains of these ancient herbivora? Not buried in tropical regions, but frozen and embalmed amid the eternal snows of Siberia, where they have been preserved intact for thousands of years. What a revolutionary change of climate do these facts imply! And how sudden must have been the translation from ultra-tropical verdure to the utter desolation of Arctic frigidity when the entombment and refrigeration of these herb-eating leviathans took place fresh from their feeding-grounds!

But now let me give another illustration nearer home—one drawn from the recent discoveries of Dr. Stirling, F.R.S., in South Australia, the importance of which, from a scientific point of view, it would be impossible to overestimate. I will shortly state the facts so far as they have yet become known. In the central part of South Australia there is a vast stony desert lying to the eastward of Lake Frome and to the westward of the Grey Range. It is described as being unspeakably arid and desolate, abounding in salt-pans, of which Lake Mulligan is the largest. This forbidding district is entirely destitute of fresh water and almost absolutely devoid of animal life of any kind. The intrepid explorer, Captain Sturt, in 1844 penetrated about half-way across this inhospitable plain, and then, after suffering great hardships, had to make his way out of it to escape absolute starvation. Up to the present time this region has been to all intents and purposes a sealed book. But a few months ago an important discovery of fossil bones was made at Lake Mulligan, and, chiefly through the scientific enterprise of Dr. Stirling (aided all through by the generous liberality of Sir Thomas Elder), this discovery has been followed up with very astonishing results. A correspondent of the *Scotsman*, writing on the spot and from his own knowledge and observations, states that, after four months' digging among the gravels of the valley of the Mulligan, some two thousand bones, representing seventy different mammals and birds hitherto unknown, have been unearthed, and safely lodged in the South Australian Museum at Adelaide. This collection comprises the first complete skeleton of *Dipro-*

todon australis, a gigantic marsupial considerably exceeding the rhinoceros in size, the remains of a giant wombat as large as a half-grown bullock, several kinds of colossal birds equalling in stature the Moa of New Zealand, and several species of gigantic kangaroos! The writer's reflection is as follows: "What a different picture of the past history of this country is brought to light by these discoveries! On the sides of these mountains lying between Lake Frome and Lake Torrens must have grown huge trees, and all around there must have been a dense tropical growth, exceeding in luxuriance the forests of the eastern slopes of the Andes in South America!"

Commenting on this remarkable sequence of animal life on the earth at different periods of its history in the same geographical areas, Sir John Lubbock observes, "Our prehistoric ancestors hunted the mammoth, the woolly-haired rhinoceros, and the Irish elk; the ancient Britons had the wild ox, the deer, and the wolf. We have still the pheasant, the partridge, the fox, and the hare; but even these are becoming scarcer, and must be preserved first in order that they may be killed afterwards."

I fear I have already trespassed too long on your kind indulgence, but the subject is a very seductive one, and, in treating of it, however briefly, it is difficult to keep within the ordinary limits of an address. But just one word in conclusion. As you will have gathered from the views I have had the privilege of placing before you this evening, I am a thorough disciple of Darwinism in the higher sense of that term. I do not think it is possible to explain on any other hypothesis the wonderful variety and complexity of living forms that inhabit this beautiful world of ours. We must, as it seems to me, acknowledge with the author of "The Origin of Species," in one of his later works, that "man, with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his godlike intellect which has penetrated into the movements and constitution of the solar system—with all these exalted powers, man still bears in his bodily frame the indelible stamp of his lowly origin." I do not accept, however, as many do, the purely materialistic theory, because I am a believer in the truths of revelation and in the spiritual destiny of man. As that of a humble worker in the field of science, earnestly seeking the truth, this is, so to speak, my confession of faith as a naturalist. To adopt Mr. Wallace's admirable language on this point, I am "thus relieved from the crushing mental burden imposed upon those who—maintaining that we, in common with the rest of nature, are but products of the blind

eternal forces of the universe, and believing also that the time must come when the sun will lose his heat, and all life on the earth necessarily cease—have to contemplate a not very distant future in which all this glorious earth—which for untold millions of years has been slowly developing forms of life and beauty, to culminate at last in man—shall be as if it had never existed; who are compelled to suppose that all the slow growths of our race struggling towards a higher life, all the agony of martyrs, all the groans of victims, all the evil and misery and undeserved suffering of the ages, all the struggles for freedom, all the efforts towards justice, all the aspirations for virtue and the well-being of humanity, shall absolutely vanish, and, 'like the baseless fabric of a vision, leave not a wrack behind.' As contrasted with this hopeless and soul-deadening belief, we, who accept the existence of a spiritual world, can look upon the universe as a grand consistent whole, adapted in all its parts to the development of spiritual beings, capable of indefinite life and perfectibility. . . . We thus feel that the Darwinian theory, even when carried out to its extreme logical conclusion, not only does not oppose but lends a decided support to a belief in the spiritual nature of man. It shows how man's body may have been developed from that of a lower animal form under the law of natural selection; but it also teaches us that we possess intellectual and moral faculties which could not have been so developed, but must have had another origin; and for this origin we can only find an adequate cause in the unseen universe of Spirit."

Art. IV.—*Notes on the Ornithology of New Zealand; with an Exhibition of Rare Specimens.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S., &c.

[*Read before the Wellington Philosophical Society, 25th July, 1894.*]

When I had the pleasure of reading a paper before you on the 13th July, 1892, I referred to the steps that had been taken by Mr. Ballance's Ministry, at the instance of our late Governor, Lord Onslow, towards preserving the native avi-fauna of New Zealand by setting apart island reserves and placing them under strict supervision. Having taken an active interest in these steps myself, naturally my first inquiry on returning to the colony, in March last, was as to how far the good intentions of the Government had been carried into effect. I was indeed glad to find that the negotiations for

the complete acquisition of the Little Barrier Island were being pushed forward, and with every prospect of speedy success, and that both there and on Resolution Island a custodian or ranger was being maintained by the Government. It is disheartening, however, to learn from the last report of the Auckland Institute that "in the meantime several natives and Europeans are living on the island, fires have been allowed to spread, and in the last week of January of this year a serious one was reported, which lasted at least a week." It is also alleged in the report that "the island has been visited by collectors, and specimens of the very birds which it was hoped might survive have been shot and brought to Auckland." I understand that effective steps are now being taken to prevent such depredations for the future. And, from what I can gather in the department, there is every reason to hope that within a measurable time the last of the native owners will have been settled with, and the private title extinguished. The whole of the island will then be Crown land, and will be under more effective control. All over the scientific world the action of the Government in this matter has been applauded. The efforts now being made, whether in the end completely successful or not, will in any case save us from the reproaches of posterity. If they should prove successful, as I believe they will, I venture to think that this service to science will bring credit and praise to the present Government when many of their more ambitious schemes and projects have been buried and forgotten. But it must be borne in mind that the conservation of the two islands I have named is only a partial carrying-out of Lord Onslow's recommendations and of the decision come to by the Government in 1892. The original proposal was not merely to protect the birds already existing on the two island reserves, notably the Stitchbird and the Whitehead on the Little Barrier, and *Notornis mantelli*, Kiwis, and Kakapos on Resolution Island; but that many other birds now living on the mainland, although becoming scarcer every year, should be systematically trapped from time to time and turned loose upon the islands. In addition to a further supply of Kiwis and Kakapos, of the different species, the birds specially marked out for these attentions were the Huia (*Heteralocha acutirostris*) and the Blue-wattled Crow (*Glaucopis wilsoni*) in the North Island, and the Thick-billed Thrush (*Turnagra crassirostris*) and the Orange-wattled Crow (*Glaucopis cinerea*) in the South Island. This could be done now, and at comparatively trifling cost; but every year it will become more difficult. It has now become a truism that the rarer New Zealand birds are passing away and will soon be extinct. But even species that were formerly very abundant all over the country are following suit, not only on the main-

land but on the small islands where the conditions of existence are so much more favourable. Mr. W. Hawkins, the well-known collector, writing to me from the Chatham Islands in August last, says, "The Fern-bird (*Sphenœacus rufescens*) and the Black Robin (*Miro traversi*) are gone. The Mako-mako and *Cabalus modestus* are going fast; and the Pigeon too. In fact Pitt Island is the only place where Pigeons and Bell-birds are to be got. . . . On the Sisters ten years ago the Maoris got a thousand Albatroses; last year they got only three hundred and fifty. They say that if I go there I'll frighten the Albatros away altogether, so they have absolutely prohibited my collecting there."

I shall now proceed to place before you my customary budget of ornithological notes. Dr. Sclater, the accomplished editor of the *Ibis*, has referred in terms of commendation to my practice of exhibiting at our meetings here the more important of the specimens to which the observations refer. I shall continue this practice, because it tends to keep up the interest of members in what is being done in this department of science. It is quite a mistake to suppose that because exhaustive works have appeared on the birds of New Zealand nothing remains to be done by the ordinary observer. In opposition to such a view, I may mention that since the publication of my last edition of "The Birds of New Zealand," in 1888, I have, through the medium of these periodical notes (without including those contained in the present paper), added no less than ten species to the list of our birds, recorded thirty-four albinisms and other abnormal varieties, and made original observations, more or less important, on eighty-four ordinary species. Others have been working in the same direction, and registering interesting facts, the most important of these contributions being a paper on the birds of the Chatham Islands by Mr. H. O. Forbes, which appeared (with two excellent illustrations) in the *Ibis* for October, 1893.

Heteralocha acutirostris, Gould. (Huia.)

Sir John Lubbock, in his charming volume "The Beauties of Nature," in an account of what he terms the Hura (meaning of course the Huia), pp. 48, 49, makes two mistakes. In the first place he calls it a Crow, whereas it has been proved to be a Starling; and, in discussing the curious modification of the bill in the two sexes and its use, he says, "When the cock has dug down to the burrow the hen inserts her long bill and draws out the grub, *which they then divide between them*" —the italics are mine—"a very pretty illustration of the wife as helpmate to the husband."

Now, I believe I was the first to observe and record the peculiar adaptation of the Huia's bill to its habits of life, in a

paper which I read before this Society in 1870, describing the conduct of a pair of live birds then in my possession (Trans. N.Z. Inst., vol. iii., pp. 24–29). But I had previously told Sir George Grey all about it, and he, with his usual felicity of expression, told the story at a meeting of the Zoological Society on his return to England. It seems a pity to destroy the pretty sentiment of the case as put by Sir John Lubbock, but science is inexorable, and the truth must be upheld. What I stated in my record of observations was this: "The very different development of the mandibles in the two sexes enabled them to perform separate offices. The male always attacked the more decayed portions of the wood, chiselling out his prey after the manner of some woodpeckers, while the female probed with her long pliant bill the other cells, where the hardness of the surrounding parts resisted the chisel of her mate. Sometimes I observed the male remove the decayed portion without being able to reach the grub, when the female would at once come to his aid, and accomplish, with her long slender bill, what he had failed to do. I noticed, however, that the female always appropriated to her own use the morsels thus obtained." I am sorry that the stern truth detracts from the poetry of Sir John Lubbock's narration.

Creadion carunculatus, Gmelin. (Saddleback.)

From Stephen Island, in Cook Strait, I received last year a fresh specimen, which was interesting as being in the full "saddleback" plumage, although a very young bird. It has very small caruncles, and a narrow yellow membrane at the angles of the mouth. The plumage is somewhat duller than in the adult, but the distribution of colours is the same. Such a specimen as this, which is still in my collection, establishes beyond all doubt the validity of *Creadion cinereus* as a distinct species.

Miro traversi, Buller. (Black Robin.)

The young of this species has the plumage slightly tinged with brown, and the feathers of the underparts have obscure margins.

Anthus aucklandicus, G. R. Gray. (Auckland-Island Pipit.)

In the Trans. N.Z. Inst., vol. xxi., p. 388, Mr. Reischek, after consultation with Professor Thomas and Mr. Cheeseman, described a new Ground-lark or Pipit from Antipodes Island, and named it *Anthus steindachneri*, after the Director of the Imperial Museum at Vienna. I have not seen the type, but the description of the bird given by Mr. Reischek indicates no difference between this bird and *Anthus aucklandicus*.

Rhipidura flabellifera, Gmelin. (Pied Fantail.)

In October, 1880, during a storm-bound visit to Motutaiko, in the Taupo Lake, I found the nest of this species, with four eggs in it, secured very neatly to a twig of kawakawa (*Piper excelsum*), a tree to which, as I have observed, the Fantail is very partial for nesting purposes. We had made our camp-fire immediately under the nest before discovering it, and, although we remained there several hours, the birds did not appear to be in any way inconvenienced by the volume of smoke that came from the driftwood fire, and enveloped them completely from time to time. Both sexes incubate in turn. There could be no mistake in this observation, because one of the birds had lost its tail, and could be readily distinguished from the other.

Rhipidura fuliginosa, Sparrm. (Black Fantail.)

On a recent visit to Papaitonga, I was much pleased to see a fine specimen of this South Island species in a clump of native bush near the homestead. It was associating with the Pied Fantail, which is particularly numerous in that locality. It was appreciably larger in size, and was in beautiful plumage, the white ear-spots being very conspicuous.

Mr. J. C. McLean, of Gisborne, in the *Ibis* for January last, gives an interesting account of the interbreeding in that district of a female bird of this species with a male of *R. flabellifera*. There were two eggs in the nest taken, and Mr. McLean thinks they are richer in colour than the ordinary egg of the Pied Fantail, "the spots being of a purplish tint, while in eggs of the pied bird they are brownish."

Petrochelidon nigricans, Vieill. (Australian Tree-swallow.)

Several instances have been recorded of the occurrence in New Zealand of flights of the Australian Tree-swallow. Mr. H. Guthrie-Smith, writing to me from Tutiri Lake, on the 20th August, 1893, says, "While up at the Mahia last week, I observed some birds like Martins or Swallows. They have been there for some weeks, I believe. They were flying high above some blossoming gum-trees when they were first pointed out to me. It was a dark afternoon; but, as far as I could see, their tails were not forked. I should be much obliged if you could tell me to what species they belong. Could they be a flight of *Hirundo nigricans?*"

Mr. James Dall, of Collingwood, also writes to me, under date of the 25th June, 1893, "During this spring, summer, and autumn there have been large numbers of Australian Swallows or Martins visiting New Zealand—apparently all parts, as I see by a late *Canterbury Times* that a pair have built a nest and are hatching young ones in a mill about

Oamaru, where they are being greatly cared for by every one. In the spring of 1892 flocks of two or three dozen were observed in the neighbourhood of Cape Farewell." I have no doubt these visitants are referable to the above species. (See "Birds of New Zealand," 2nd ed., vol. i., pp. 74–76.)

Prosthemadera novæ-zealandiæ, Gmelin. (Tui.)

On examining a series of ten eggs I find that they vary a good deal both as to shape and colouring. For the most part they are of a narrow ovoido-elliptical form, with a very pronounced smaller end, but a few of them are less acuminate, and one is broadly ovoid. A typical one measures 1·25in. by 0·80in.; the more rounded one I have mentioned measures 1·125in. by 0·88in. This is almost entirely white, with only a few indistinct, widely-scattered, rusty or pale-red spots towards the larger end. The most highly-coloured example is of a delicate creamy-white or salmon tint, the larger end darker and thickly spotted and dotted with pale brown, these markings forming an indistinct zone. Two other eggs are almost exactly similar to this one, but with a paler ground, and all three are probably from one nest. Another set of three have scattered, somewhat obscure pale-brown markings over the entire surface. The three remaining ones (presumably from one nest) are white, with here and there a speck of pale brown, chiefly at the larger end.

Anthornis melanura, Sparrm. (Korimako.)

At 7 p.m. on the 26th October we left Tokanu for Tapuaeharuru in a four-oared boat, manned by a good crew of Armed Constabulary. It was a beautiful, calm day, and the surface of the lake was a perfect mirror. Five miles from land we could still hear the hollow boom of the Bittern, and the barking of the curs in the Maori village. There was not a breath of air to cause a ripple on the bosom of the lake, and the rock-bound margin of Motutaiko danced in the mirage of the morning sun. Our men were settling down to a long pull of twenty-five miles, and we had just arranged to make straight for Motutaiko and rest there for an *al fresco* lunch, when the seaman Todd, who was in charge of the crew, pointed to an advancing ripple from the southward; and, without a moment's warning, we were overtaken by a squall which increased in fury with amazing rapidity. Within the brief space of five minutes, instead of dreamily rowing on the placid waters, we were pitching and tossing in an angry sea—the rudder was powerless, and the oarsmen had the utmost difficulty in keeping the boat's head on. We shipped several heavy seas, and struggled on for hours, sometimes drifting, at others just holding our own, as the storm varied in force, the

men all pulling with desperate strength, knowing that to relax for a moment meant swamping and destruction to us all; for the best swimmer could not long have survived a capsize in such a sea, and with the atmosphere and water so intensely cold. After some four hours of unflagging labour, a lull in the storm enabled us to get under the lee of Motutaiko; but half an hour after we had landed, in a little rocky cove on the western side of the island, the storm redoubled in force, and for some hours such a gale blew as had not been witnessed in the lake for years. The "little white horses" of the sea chased each other in quick succession, and the spray rose in clouds as the winds swept over the tempestuous waters. Of course the first consideration on reaching land was a sense of gratitude at having escaped from a very perilous position; but I was delighted on landing to hear on all sides the silvery notes of the Korimako. As is well known, this little songster, which formerly was so abundant everywhere, has for a long time past been practically extinct in the North Island. At the time of this visit to Motutaiko it had not been heard of for several years on the mainland, although it was known to exist on certain islands off the coast, such as the Little Barrier in the Hauraki Gulf, and the Island of Kapiti in Cook Strait; and the generally-accepted theory had been that the chief factor in its extermination was the introduced rat. That certainly was my own belief. But a fact now came to my knowledge which seemed to tell very much against that theory. It was this: The island on which I so unexpectedly met with the Bell-bird is famous for its rats. It is covered with pohutukawa trees and koromiko scrub, and the whole island swarms with rats. The ground is in places almost honeycombed with their burrows, for in one spot I counted no less than five holes within a radius of eighteen inches. So numerous were they that Topia Turoa had found it necessary to turn some cats adrift on the island to reduce their numbers before he could put in a crop of potatoes on one of the slopes; and wind-bound boats lying in the little sandy cove at night have, it is said, been invaded by multitudes of rats and had all their provisions carried off.

Then, again, as to the rat theory, it is a significant fact that, although the Korimako has disappeared from the North Island, it has continued to exist in the South Island, although in somewhat diminished numbers; and, so far as I am aware, the introduced rat is as plentiful there as in the North. There may be destructive causes in operation of which we have no present knowledge.

I lately had an opportunity of examining a collection of twenty-three eggs of this species, all from the South Island. I made the following notes: They vary only very slightly in

size, but exhibit a considerable amount of variation in the markings. In most of them the ground-colour is white, in others it is suffused with a delicate pinky blush. Some have the larger end smeared and the rest of the surface irregularly spotted with rusty-brown; in others the brown markings form an indistinct zone; in some the brown is concentrated at the larger pole, the rest of the shell being entirely free from markings. In some specimens these markings are irregular, being streaky or blotchy; in others they are rounded dots, being more or less confluent at the pole. Their colour varies from a dull umber-brown to a warm reddish-brown. In a few of them the markings are distributed over the entire surface in the form of minute speckles, without any appearance of a zone or any congestion at the larger pole. Two that I selected for the purpose measured, respectively, 0·75in. by 0·625in. and 0·88in. by 0·55in., both being slightly pyriform.

Pogonornis cincta, Gray. (Stitch-bird.)

I have lately had an opportunity of examining a large series of specimens collected for Mr. Spencer on the Little Barrier Island, before that last resort of this species came under Government protection. The young male has exactly similar plumage to that of the adult female, except that there is a broad spot of canary-yellow near the bend of the wing. When the first moult commences this expands into a conspicuous band on the humerus, after which there is a gradual change of the body-plumage. I have described in "The Birds of New Zealand" a beautiful specimen in the Auckland Museum in a transitional state of plumage.

Halcyon vagans, Lesson. (Kingfisher.)

I am indebted to the kindness of Mr. Taylor White, of Hawke's Bay, for the opportunity of exhibiting this evening a lovely specimen of our Kingfisher. It is a perfect albino, every feather being of the purest white, and the whiteness extending even to the bill and feet.

Nestor meridionalis, Gmelin. (Kaka.)

This fine parrot is far less plentiful than it formerly was, and this is the inevitable result of settlement and the consequent destruction of the forests. In districts where formerly it existed in thousands its scream is never heard, and to many of the new settlers the bird is quite unknown. It is semi-nocturnal in its habits, and towards evening becomes very animated, flying over the tree-tops in an excited manner, generally in parties of three, uttering its harsh scream. This changes to a soft musical whistle as the birds alight; and, in doing this, they always select, as a post of observation, the

withered top of some aged tree, always climbing to the highest limbs, their progression being by a succession of short hops.

Platycercus novæ-zealandiæ, Sparrm. (Red-fronted Parrakeet.)

At Tapuaeharuru, on the Taupo Lake, I saw a fine caged example of this species in which the crown and sides of the head had a wash of yellow over the green.

Platycercus erythrotis, Wagler.

From a specimen received by the "Hinemoa," on her recent visit to Antipodes Island, I am able to give the measurements of this species: Length, 17in.; extent of wings, 12in.; wing from flexure, 5·75in.; tail, 6in.; bill, along the ridge 0·9in., along the edge of lower mandible 0·5in.; tarsus, 0·9in.; longer foretoe and claw, 1·25in. It proved, on dissection, to be a male.

Count Salvadori is of opinion that this species should be regarded as *Platycercus hochstetteri* (cf. Salvad., Cat. B. B.M., xx., p. 577), *Platycercus erythrotis* being the representative form on Macquarie Island. I have never seen the British Museum example mentioned by Dr. Finsch in his "Die Papageien," vol. ii., p. 275; but he treats it as a mere synonym of *Platycercus novæ-zealandiæ*. In any case there seems to be much uncertainty about the origin of this specimen; and Captain Fairchild informs me that he has been unable to get any evidence as to the existence of a Parrakeet on Macquarie Island.

Platycercus unicolor, Vigors. (Antipodes Island Parrakeet.)

I take this opportunity of exhibiting an egg of this species which was laid by a captive bird on board the "Hinemoa" on her last voyage from the islands. As will be seen, it is perfectly white, with a smooth surface, and almost spherical in shape, measuring 1in. in length by 0·9in. in extreme width.

Circus gouldi, Bonap. (Harrier.)

Although the Bush-hawk has almost entirely disappeared from all the settled districts, the Harrier maintains its ground, and is extremely abundant on some of the sheep-runs. At Papaitonga my son lately saw one with a perfectly white head, but it was very shy, and he was unable to shoot it. These hawks are in the habit of hunting along the shores of the lake, and are a perpetual terror to the young ducks. They are destructive also to the eggs of birds nesting in the sedge, on one occasion no less than fifteen eggs being taken from a goose's nest. They are bold enough, too, in their manner of attack. One day I saw three or four large Sea-shags (*Phala-*

crocorax novæ-hollandiæ) perched on the naked branches of a lofty matai near the edge of the lake, looking very fine as they balanced their bodies against the blue sky beyond. Presently a Harrier appeared in sight, and, without a moment's hesitation, swooped down on the group of Shags, and they, much to my surprise, instead of showing fight, made precipitately for the water. On another occasion one of these hawks made a determined attack on a flock of Black Teal (*Fuligula novæ-zealandiæ*) well out on the lake. The ducks splashed and dived, and evinced every sign of terror, and the assailant kept up the pursuit for fully half an hour, but without effect.

Apart from these depredations, I have reason to fear that these hawks have been interfering with the Mallards and other English birds recently placed by me on the Papaitonga Lake.

Harpa ferox, Peale. (Bush-hawk.)

At Waipuna, in Hawke's Bay, I saw, on the 17th March, a young Bush Hawk boldly attack a litter of kittens, whilst actually under the protection of the maternal cat! It seized one of them and lifted it some feet in the air. The quarry managed, however, to disengage itself and dropped to the ground. The hawk, which, from its size, I took to be a female, then settled on the dry limb of a tree close by, apparently to await another opportunity; and there we left her, balancing her body in an almost horizontal position, and looming large against the clear blue sky beyond.

Harpa novæ-zealandiæ. (Quail-hawk.)

The egg of this species is a very pretty object. I have now four specimens before me. They are of uniform size, and broadly ovoido-conical, measuring 2in. by 1·4in. Pale-brown, richly splashed and spotted over the entire surface with reddish-brown, especially at the larger end, where there is a mixture of blackish-brown with the brighter colour.

Carpophaga novæ-zealandiæ, Gmelin. (Wood-pigeon.)

It is very regrettable to see how scarce this fine Wood-pigeon is becoming in all the settled districts. Even as late as 1880 it was extremely abundant in the Forty-mile Bush. I find the following entry in my diary for April of that year:—

The Pigeon is now feeding on koroi, the small red berry of the kahikatea, which is exceptionally abundant this year, the trees by the roadside as we passed through the Forty-mile Bush having a russet hue from the abundance of the ripe fruit. The miro berry comes in next month, and the whanake

early in June. The pate (called "patete" by the Ngatikahungunu, and "kotete" by the Ngatiraukawa) is now in fruit, the long spikes or drupes of berries hanging in conspicuous clusters along the edge of the forest. This, too, is a favourite food of the Wood-pigeon at this season. The houhou, which has clusters of black berries, like the English elder-bush, contributes likewise to the bountiful bill of fare; so also does the karamu (*Coprosma lucida*), and a much larger kind, called raurekau by the natives, producing a brighter-red berry, and now in full bearing. The Tui and the Kaka also regale themselves at this season on these sweet berries.

The flight of the Wood-pigeon is rapid and direct at first, then oblique and somewhat tumbling: that is to say, the bird turns over first on one side, then on the other, in a very measured manner. The tail is partially spread during flight.

Many beautiful varieties of this fine Wood-pigeon have been recorded from time to time, but there is a specimen in the Colonial Museum of which no description has yet been published. In this bird the plumage of the head, neck, breast, and mantle is largely varied with pure white, which predominates on the neck, the normal bronzy plumage shining out in the midst of it, especially on the breast, with a very pretty effect; there are also a few scattered white feathers on the wings and tail. This handsome bird was obtained at Eketahuna, and presented to the Museum by Mr. R. R. Greville.

There are two beautiful specimens in the possession of Mr. C. J. Robinson, of the Upper Hutt. One of these, shot by himself on a miro tree at the summit of the western range, opposite Wallaceville, in June, 1892, has the head, neck, and breast, and the upper surface generally dull yellowish-brown, shaded with darker; the primaries and tail-feathers clove-brown, the latter darker; the higher interscapular region or shoulders and the small wing-coverts rich vinous-brown; some of the outer coverts pale-brown with vinous edgings; the whole of the under surface pure white. Bill and feet red. The other bird was shot in the same spot about eight days later. It is a lovely albino, the entire plumage being pure white, with just the faintest tinge of cream, or, so to speak, another shade of white on the breast; and on the smaller wing-coverts there is a pale wash of cream. The primaries and tail-feathers are pale cream with pure-white shafts. Bill and feet red.

A specimen which I lately received from Nelson has the white of the underparts, especially along the junction with the bronze plumage of the breast, washed with chrome-yellow, and the under tail-coverts are entirely of that colour. It is apparently an adult bird, and is marked "female" by the collector.

Carpophaga chathamiensis, Roths. (Chatham Island Wood-pigeon.)

I have very much pleasure in exhibiting this evening a specimen of the new species of Pigeon mentioned by me in a former paper,* as it is an excellent illustration of what I have recently said about the development of insular forms.

Gallinago pusilla, Buller. (Chatham-Island Snipe.)

Gallinago huegeli, Tristram. (Snares Snipe.)

The Bulletin of the British Ornithologists' Club for June, 1893, contains a communication from the Rev. Canon Tristram, from which I extract the following: "In the *Ibis* for 1869, p. 41, Sir W. Buller described a second species [of Snipe] from the Chatham Islands as *Gallinago pusilla*. Very few specimens have been received, but the species has twice been obtained in New Zealand (to which it is evidently an occasional wanderer): once by Sir James Hector, in the Gulf of Hauraki, and once by Mr. F. B. Hill, on Little Barrier Island. All doubts as to its being a distinct species have recently been set at rest by the large number of specimens obtained in the Chatham Islands by the collectors of the Hon. Walter Rothschild and Mr. H. O. Forbes. I have examined more than twenty specimens, and find that all of them agree in every respect, and cannot be confused with the Auckland Island species. But when Sir W. Buller published his second edition of the 'Birds of New Zealand' he had, unfortunately, sent back to New Zealand his only specimen from the Chatham Islands, and borrowed from me a specimen which had been obtained by Baron A. von Hügel on the Snares, seventy miles south of the southern extremity of New Zealand. This I had put down as *Gallinago pusilla*, having at that time never seen a Chatham Island specimen. It is very accurately figured and coloured in Buller's second edition; but it proves to be very different from the true *G. pusilla*. The only other example in existence, so far as I am aware, is a second specimen obtained on the Snares at the same time by Baron A. von Hügel, and in the collection of the Hon. Walter Rothschild."

Canon Tristram says, "This species may at once be distinguished from its congeners by its much redder hue, and especially by the remarkable fineness and delicacy of its markings, the edgings of the upper plumage and the striation and bands on the lower surface being much smaller, closer, and more distinct. In the other two species (*Gallinago pusilla* and *G. aucklandica*) the abdomen and thighs are whitish, while

* Trans. N.Z. Inst., vol. xxiv., p. 80.

in this they are thickly barred. In this species the three outer tail-feathers on each side are attenuated, with a white edging; in the others only the two outer pairs of tail-feathers appear to be so attenuated."

Gallinago tristrami, Roths. (Antipodes-Island Snipe.)

I have much pleasure in exhibiting a specimen of this rare Snipe, obtained on the last visit of the "Hinemoa" to Antipodes Island, and kindly lent to me by Mr. Bethune, the second engineer.

In his communication relating to *Gallinago huegeli*, cited above, Canon Tristram made the following remarks: "There would appear to be three species of *Gallinago* in the islands round New Zealand: *G. aucklandica* in the Aucklands, *G. pusilla* in the Chathams, and *G. huegeli* in the Snares, all being sedentary, or nearly so, in their several localities. To these further research will probably add a fourth from Antipodes Island, whence a single specimen has been received by Sir James Hector, who states it to be larger, darker in plumage, and with a more curved bill than the Auckland-Island species. Unfortunately he has not described it." Shortly after this a specimen was obtained by the Hon. Walter Rothschild, who described it at a meeting of the B.O.C., and dedicated it to Canon Tristram.

Larus dominicanus, Licht. (Black-backed Gull.)
Larus scopulinus, Forst. (Red-billed Gull.)

We have an excellent proof of the wisdom of protective legislation in the numbers and increasing tameness of the Seagulls that now frequent our harbours and estuaries. Not only are these birds very ornamental as they rest on the wharves and jetties, or hover lightly among the shipping at its anchorage, but they do good service to mankind as scavengers of the water by devouring the garbage which will inevitably find its way into the water in the vicinity of human habitations, and which, unless consumed, decomposes, and vitiates the atmosphere. On my last visit to Auckland I was much interested at seeing scores of seagulls of both species (*Larus dominicanus* and *L. scopulinus*) crowded together on the ridge-boards of the sheds on the Queen-street Wharf, in the very midst of the busy traffic. After years of rigid protection the birds have become quite familiar with the presence of man, and are, indeed, practically domesticated. What will happen in the course of time I saw exemplified at Glasgow, where hundreds of Kittiwake Gulls are to be seen all day long disporting themselves in the turbid waters of the River Kelvin, as it flows through the grounds in front of the Hunterian Museum. They are just as fearless and confident as domestic fowls, being wholly

indifferent to the stream of passengers to and fro on both sides of the river. I met with another instance of this at Blairquhan, the country seat of Sir Edward Hunter-Brown, Bart. Here, owing to the close protection given to a small lake in the park, a couple of hundred Wild-duck had become perfectly tame, and would come up every day to the keeper's house to be fed. These same birds on being seen on the River Girvan close by, where shooting is allowed, are as shy as ever. So much for the intelligence of the common Wild-duck, which has learned to regard the park lake as a sanctuary, where it is perfectly safe from molestation! But to return to the Seagulls. The manner in which they have increased in Wellington Harbour during the last few years, in spite of advancing traffic, is a striking proof of the efficacy of this protection. At Pitone, where the Gear Meat-freezing Works are situated, there is of necessity a considerable discharge of refuse matter, and the number of Seagulls, of both species, that congregate there on the beaches and gravel-banks is something surprising.

On my last visit to Tokanu, on Lake Taupo, I noticed many hundreds of birds flying overhead, and the natives assured me these were the tarapunga (*Larus scopulinus*) on their regular migration from the Rotoaira Lake. This was on the 25th October. The birds were at a considerable elevation, presenting peculiar combinations; at one time flying in closely-packed lines, then forming into a wedge-shape, and then scattering again like a flock of crows, and uttering all the time loud cries of *kek—kek—kek*. Large contingents of the birds had already arrived, because they were to be seen crowding together in large numbers on the exposed sand-banks just above the surface of the water.

Sterna frontalis, Gray. (Common Tern.)

On the Taupo plains, where there are thousands of sterile acres covered with manuka scrub, about five or six miles inland of the lake I observed two Terns, apparently of this species, hovering over the ground, although I found it difficult to imagine what they could find to attract them in such a barren locality. Probably they were in quest of lizards.

This species of Tern frequents the Taupo Lake, and so does *Sterna antarctica*.

Sterna fuliginosa, Gould. (Sooty Tern.)

I have received a good many specimens from the Kermadec Islands. Mr. Cheeseman writes, "It is called the 'Wide-awake' bird by the Bells, and breeds in immense numbers in the summer-time, but leaves the group altogether in the winter."

Ocydromus greyi, Buller. (North Island Woodhen.)

This species of Woodhen is still numerous on the wooded hill-sides and mountain gullies in the Murimotu-Taupo country. It is seldom met with in the open country, except at one particular season, when the birds are exceedingly fat, and the natives catch large numbers by running them down with dogs.

It is a very remarkable fact in local botany that on the arid lands forming the Onetapu Desert, and on the slopes of Ruapehu Mountain, where the climate is very rigorous, certain native pines, which in the lowlands attain to a considerable height as forest trees, are represented by dwarfed forms of the same species, not more than a few inches in height, and often assuming a creeping habit. These degraded forms, which are specifically identical with their forest relations, resemble them exactly in their fructification. The berries borne by these pigmy growths equal in size, and sometimes even exceed, those of the forest trees,—the fruit of the dwarf totara, for example, being sometimes double the size of the normal berry, while those of the miro, kahikatea, and rimu are at least fully equal to the berries produced by the forest trees. When these miniature woods are laden with ripe mast the Woodhen leaves the shelter of the woods and comes out into the open to revel in plenty. As already stated, the birds then become unusually fat, and, owing to their diminished activity, become an easy prey to the natives. Captain Mair informs me that he has known of a native with a good dog, ten years ago, killing as many as eighty in a single day. Pigeons and kakas, also, are said to resort to these subalpine woods in considerable numbers to feed on the ripe fruit. When camped on the edge of a red-birch forest near the Mangataramea Stream (at an elevation of 3,000ft.) I heard the loud cry of the Woodhen every night, but I never met with the bird in the open country, and the sheep-farmer with whom I was staying appeared never to have seen one.

I was much struck with the beauty of these clumps of bush in the Murimotu highlands, where the Woodhen was so numerous. Some of them consist entirely of kawaka (*Librocedrus doniana*) a very ornamental tree of bright-green foliage and tapering growth, with a trunk like a miniature *Sequoia*. This is plainly seen when a fire has passed through the forest and left the trees dead and naked. In some places you meet with the strange sight of the whole forest apparently hewn down, and strewing the ground with bleached and charred trunks. The explanation is this: that these trees are generally hollow near the ground, and have only a feeble support of lateral roots. Consequently, when a fire has passed through

and killed the trees, the dead timber cannot long resist the action of the weather, and one after another the "cedars" topple over with the passing blast, till at length not a single trunk remains standing, and an appearance is presented of utter wreck and desolation. For the most part the trees are of small size, but Captain Mair informs me he has often met with them 4ft. in diameter at the base. Another tree that adds to the novelty of these subalpine woods is the silver-birch—a graceful and elegant tree of bright foliage, resembling at a short distance the larch, and showing up conspicuously amongst the black- and red-birch with which it mingles. In these mountain solitudes, however, there is very little animal life to engage the attention of the naturalist. On the summit of Gentle Annie, in fine weather, I met with what appeared to be a smaller and very bright variety of the Yellow Admiral butterfly, but I could not catch any. I saw occasionally a small lizard, which I referred to *Tiliqua zealandica*. Bird-life is scarce, except at certain seasons and in particular localities.

Ocydromus earli, Gray. (Brown Woodhen.)

I have to exhibit to-night another remarkable albinism. It is that of the Brown Woodhen of the South Island. The forehead, face, foreneck, and breast are pure white; five of the quills in one wing and six in the other are entirely white; there are a few white feathers scattered among the wing-coverts, and there is a large admixture of white in the plumage of the abdomen, sides of the body, and flanks. The rest of the plumage is normal. To judge from its large size, it is a male bird. I obtained it, through a dealer, from the west coast of the South Island.

Ocydromus brachypterus, Lafr. (Black Woodhen.)

Dr. Sharpe reports that he has examined the type specimen of *Gallirallus brachypterus* from the Caen Museum, for the loan of which he was indebted to Professor Joyeux-Laffine, the Director of that Museum. Dr. Sharpe points out that the species has been the subject of much controversial opinion, but that it is evidently the same as *Gallirallus fuscus* of Du Bus, which must therefore be known as *Ocydromus brachypterus* (Bull. B.O.C., Jan., 1873). This being so, the Buff Woodhen, which I referred to *Ocydromus brachypterus* in my second edition of "The Birds of New Zealand," becomes *Ocydromus hectori*, Hutton (Trans. N.Z. Inst., vol. vi., p. 110, 1874), or, perhaps more properly, *Ocydromus troglodytes*, Gmelin.

Porphyrio melanonotus, Temm. (Swamp-hen.)

I have to exhibit this evening a curious example of the Swamp-hen or Pukeko, lately received by me from Nelson. All the primaries in each wing are crossed near the tip with a broad band of yellowish-white; the secondaries are similarly marked, but not so sharply, and so are most of the wing-coverts, imparting a mottled appearance to the upper surface. The tail-feathers are broadly tipped with yellowish-white, and there are a few scattered white feathers on the shoulders and on the underparts. The rest of the plumage is normal.

I take this opportunity of mentioning a Swamp-hen from the Chatham Islands described as new by Dr. Bowdler Sharpe under the name of *Porphyrio chathamensis* (Cat. Birds Brit. Mus., xxiii., p. 202). He gives the following diagnosis of the species: "Similis *P. bello*, sed gutture toto nigro, pileo concolore; præpectore saturate cyaneo: tibiis nigris, abdomine imo concoloribus"; and he adds, "The tints are difficult to describe, but the differences are well seen on comparison with *P. bellus*."

It seemed to me highly improbable that there should be a differentiated species of this widely-spread form at the Chathams, and, although holding Dr. Sharpe's judgment in great respect, I went to the British Museum to examine the type for myself. A single glance satisfied me that the supposed new species was nothing but our ordinary Swamp-hen in an unusual, but by no means uncommon, phase of plumage. The dark head and throat, the highly-coloured breast, and dark underparts are merely individual differences of colour and have no specific value. I would undertake to pick out several birds exactly similar to Dr. Sharpe's at the close of a day's shooting in any locality where Pukekos are numerous.

The Swamp-hen of New Zealand is abundant at the Chatham Islands, and the existence there of another species of so diffuse a form seemed on the face of it most unlikely.

Diomedea regia, Buller. (Royal Albatros.)

In the Hunterian Museum at Glasgow I saw an undoubted example of this species labelled as *Diomedea exulans*. The Curator told me the specimen had been in the Museum many years, and that it was recorded as having come from the Cape of Good Hope.

The following passage in Cook's "Second Voyage" probably refers to this species, and, if so, it is without doubt the earliest record of the bird: "In the afternoon of the 21st [January, 1773] being in the latitude of 64° 24′ South, longitude 42° 19′ East, we saw a white Albatros with black-tipped wings."

Diomedea melanophrys, Boie. (Mollyhawk.)

In the perfectly adult bird the bill is of an uniform gamboge-yellow, shaded with orange on the hook, and with a very fine line of black around the base of both mandibles ; feet delicate blue-grey, darker on the joints and interdigital webs; claws white-horn colour.

Diomedea exulans, Linn. (Wandering Albatros.)

I have already mentioned the tame Albatros which lived so long at Government House, under Mr. Gillington's assiduous care.* But there is a still more remarkable instance of the kind, for Mr. Martin Chapman had a live one in his possession for several months, having obtained it as a nestling from the Auckland Islands. It partook freely of fat meat, and had an inordinate appetite. It became quite tame, but on being provoked would snap audibly with its mandibles.

Captain Fairchild informs me that when visiting the Brothers and Stephen's Island in June last, in perfectly calm weather, he saw at least six hundred Albatroses resting on the water, and that from the anchorage off the latter he counted as many as a hundred. He says he has noticed that during the last five years they have been getting more and more plentiful off the New Zealand coast. Prior to that he never saw more than a straggler now and then, and generally at Flat Point, about midway between Wellington and Napier.

Diomedea fuliginosa, Gmelin. (Sooty Albatros.)

Captain Fairchild states that about the end of May last or beginning of June, when off Milford Sound, in the "Hinemoa," he saw fully a dozen Sooty Albatroses coursing about together —a most unusual circumstance.

Diomedea bulleri, Rothschild. (Buller's Albatros.)

The bird which has hitherto been called *Diomedea culminata* in our New Zealand lists has been pronounced by Mr. Salvin a new species, and is described in the *Ibis* (vol. v., 1893, p. 572) by Mr. W. Rothschild, who has been good enough to dedicate this new form to myself. The type of the species, besides a very large series of representative specimens, is in the Rothschild Museum at Tring.

The following is the diagnosis: *Thalassogeronti culminato* quoad colores similis, sed rostro pallidiore, culmine ad basin latiore, ad latera attingente, culmine omnino flavo ; alis subtus niveis. He adds, "It differs materially from the true *Thalassogeron culminatus* (Gould), a species of Ridgway's genus *Thalassogeron*, the base of the culminicorn being

* Trans. N.Z. Inst., vol. xxv., p. 76.

separated by an interval of soft skin from the latericorn. In this respect the present species is somewhat intermediate between *Diomedea* and *Thalassogeron*, but the base of the culminicorn, though not so well developed, distinctly spreads and has a well-defined posterior margin."

Diomedea salvini, Rothschild. (Salvin's Albatros.)

On the same unimpeachable authority, Mr. Rothschild has renamed the bird which has hitherto been known to us as *Diomedea cauta*, and has referred it to the genus *Thalassogeron*. The type of Gould's *T. cautus* is in the British Museum, and the present form is distinguished thus: Similis *Th. cauto*, sed rostro multo minore, ad basin minus elevato, plumbescente nec albido, tarsis et digitis brevioribus quoque dignoscendus. He adds, "In coloration this species is apparently greyer on the head and neck, the dark loral mark in front of the eye being very conspicuous."

Majaqueus æquinoctialis, Linn. (The "Stinker" of whalers.)

In a former paper (Trans. N.Z. Inst., vol. xxv., p. 62) I mentioned, on the authority of the carpenter of the "Hinemoa," a new species of Petrel at the Auckland Islands, of which he had obtained two specimens, and which, from his account of it, I referred to *Majaqueus æquinoctialis*. I have now the pleasure to lay before you two specimens (male and female), lately obtained through Mr. Smyth, the well-known taxidermist at Caversham, so that the claim of this fine species to a place in our list is beyond question. The peculiar odour which is characteristic of all Petrels in life, and never entirely quits the dried skin, is very pronounced in this species, and quite justifies the name by which whalers and sailors distinguish it.

Majaqueus parkinsoni, Gray. (Black Petrel.)

Mr. J. Brough, of Nelson, in sending me a skin of this Petrel, furnishes the following notes: "This bird was killed in February on a dividing-range between the head of the Heaphy and the Big River. It was found in a hole at the roots of a huge rata, in the midst of dense forest. I am quite satisfied that this bird is the 'Night Demon' of our diggers. I had a live one some time ago from Collingwood, and I kept it for three months; so I had every opportunity of observing its habits. It was strictly nocturnal, and would never feed by day. On windy nights the bird would become very excited, and then it would give vent to the hysterical laugh or scream from which it takes its name of 'Night Demon.'"

Œstrelata leucophrys, Hutton. (Kermadec-Island Petrel.)

Under the above name Professor Hutton has described a Petrel received from the Kermedec Islands. The description was to appear in the "Proceedings" of the Zoological Society after I left England, and a beautiful plate of it had been prepared by Keulemans. It is as well to have it on record, but it is by no means certain that it is a good species. I had previously taken Home two specimens of this Petrel, which I had received from Captain Fairchild. On submitting them to Mr. Salvin, the great authority on the Petrel family, he unhesitatingly pronounced it an aberrant form of *Œstrelata neglecta*, which has a great tendency to vary. At Mr. Salvin's request, I afterwards examined Professor Hutton's type at the Zoological Society's rooms, and found it was identical with the species I had submitted to him. Mr. Salvin's own verdict was, "a bad species and a bad name."

Œstrelata nigripennis, Rothschild; *Ibis*, vol. v., 1893, p. 573.

A third new species pointed out by Mr. Salvin in Mr. Walter Rothschild's beautiful collection of Petrels at Tring, and named as above, comes from the Kermadec Islands. "This species belongs to the *Œ. cooki* (Gray) section of the genus *Œstrelata*, of which *Œ. defilippiana* is also a member. It differs from all its congeners in having a short, stout, wide bill, and in the almost total absence of white on the inner webs of the outer primary beneath; the under wing-coverts, with the exception of a rather wide margin, being white, as well as the axillary feathers."

I do not know what authority Professor Hutton had for the following reference to me in his recent communication to the Zoological Society (Proc. Z.S., 1893, p. 750), of which he has kindly sent me a copy: "*Œstrelata nigripennis*, Rothschild (1893) = *Œ. cooki*, Cheeseman (*fide* Buller), Trans. N.Z. Inst., vol. xxiii., p. 224; not of Gray." I am not aware that I ever saw Mr. Cheeseman's specimen; and there is certainly no warrant for this statement in that gentleman's paper (*op. cit.*) on the Kermadec Petrels. Where Mr. Cheeseman sought my assistance in identifying his specimens he has mentioned the fact.

Œstrelata axillaris, Salvin; *Ibis*, 1893, p. 264.

This is a very interesting addition to our list of native species. In the collection of birds made by Mr. Hawkins at the Chatham Islands, there were two specimens of a Petrel allied to *Œstrelata cooki*, but differing in several marked characters, notably in having black axillary plumes. Mr. Salvin states, "The skins were not quite adult, but were marked

male and female. The birds had been shot on the south-east island on the 8th May, 1892."

Œstrelata cervicalis, Salvin. (Sunday Island Petrel.)

Shortly before I went to Europe, Captain Fairchild kindly presented me with a beautiful Petrel from Sunday Island, in both adult and young states. The bird appeared to me to be an entirely new species, but, as I was going Home, I decided to delay my publication of it till I could compare my specimens with the types in the British Museum. But I was too late with it, for, in the meantime, a Captain Carpenter had sent a skin to the Museum, and Mr. Salvin had named it as above. It had fallen into good hands; and my only regret in the matter was that I had wished to connect Captain Fairchild's name with this fine species.

Œstrelata affinis, Buller. (Mottled Petrel.)

Professor Hutton is in error in stating (*loc. cit.*, p. 753) that Mr. Salvin had identified my *Œstrelata affinis* with *Œ. gularis* (Peale). Had our acknowledged authority on Petrels, Mr. Salvin, so identified my bird, I certainly should not have described and figured it as *Œstrelata affinis* in my second edition of "The Birds of New Zealand." While admitting the species, Mr. Salvin suggested that it might prove to be the same as *Œ. gularis*, Peale (see *Ibis*, 1888, p. 358), and so the matter rests. Professor Hutton knew this perfectly well, because I had stated the facts in my account of the species. The type of *Œstrelata gularis* is in the Smithsonian Institution, and neither Mr. Salvin nor I have had an opportunity of comparing it with *Œ. affinis*, mihi.

Puffinus gavia, Forst. (Forster's Shearwater.)

A nestling obtained in the Hauraki Gulf, on the 8th November, was covered with very long and thick down of extremely soft texture, and dark slate-grey, on the upper parts; thick and close, and of a paler grey, on the under parts, fading to whitish on the crop and foreneck. Black feathers just beginning to appear on the wings.

Puffinus griseus, Gmelin. (Sombre Shearwater.)

A nestling obtained from one of the islands in the Hauraki Gulf, on the 18th November, was covered with thick down, long, extremely fine, and dark slate-grey in colour on the upper parts, shorter and thicker on the under parts; paler grey on the sides of the body; white on the foreneck, crop, and down the centre of the abdomen, in a broad band, to the vent.

Puffinus chlororhynchus, Lesson.

I do not know what authority Professor Hutton had for citing me thus, in a recent communication to the Zoological Society of London: "*Puffinus chlororhynchus,* Lesson; Buller, 'Birds of New Zealand,' 2nd ed., vol. ii., p. 235; *P. cuneipes,* Cheeseman (*fide* Buller), Trans. N.Z. Inst., vol. xxiii., p. 226; not of Gould." On turning to Mr. T. F. Cheeseman's paper I do not find any justification for the reference. As a matter of fact I have never seen his specimens of this bird. I described both species in my second edition of "The Birds of New Zealand" (see pages 234 and 235), and am therefore familiar with them. From the Kermadecs I received two examples of *Puffinus chlororhynchus,* just as I was starting for England. I took them with me, and, on submitting them to Mr. Salvin, he confirmed my identification.

Puffinus assimilis, Gould. (Allied Shearwater.)

A fledgling which I have received from Sunday Island (one of the Kermadecs) is a very pretty object. The plumage is as in the adult, except that the longer wing-coverts and inner secondaries are minutely tipped with white. But the long, fluffy, dark-grey down still adheres to the sides of the body, and as the bird squats it looks as if reposing in a luxurious nest of down, which projects an inch or more from the body, and has a charming effect.

Anas chlorotis, Gray. (Brown Duck.)

I am indebted to Captain Mair for another partial albino of this species, which was shot by him on a lagoon near the Manawatu River. It has the forehead, sides of the head, nape, and hindneck white; shoulders and mantle with white feathers intermixed with the brown, the former preponderating. Rest of the plumage normal.

A specimen which came into my possession some time ago (now in the Rothschild Museum) has the sides of the head, crown, hindhead, and upper part of neck pure white, varied only by irregular patches of brown extending from the base of the upper mandible to the eyes, and thence across the vertex. Most of the small wing-coverts, also one secondary and one primary in each wing, are pure white; of which there are also touches near the tips of the other quills. The rest of the plumage is normal, except that the margins of the dorsal feathers are somewhat lighter than in ordinary birds.

Anas superciliosa, Gmelin. (Grey Duck.)

I have already recorded some remarkable eccentricities in the breeding of the common Grey Duck. I find the following in one of my note-books: At one end of the little island of

Motutaiko, in Taupo Lake, on a pohutukawa tree overhanging the water, and at an elevation of 12ft. from the surface, a pair of these Ducks, for several successive seasons, re-formed their rude nest and brought forth their young.

Hymenolæmus malacorhynchus, Gray. (Blue Duck.)

A specimen of this Duck from Dusky Sound which passed through my hands differed from ordinary examples in having the whole of the plumage of a silky texture, and the entire breast in front and on the sides thickly studded with dark chestnut-brown spots, becoming almost confluent in places.

Aptenodytes longirostris, Scop. (King Penguin.)

The examination of a series of eight eggs gave me the following result: They exhibit much variety in size and shape; the typical form is pear-shaped, but sometimes they are elongate, inclining to an elliptical form, with an attenuated smaller end. The largest of the former in this series measures 4·1in. by 3in.; and the smallest of the latter measures 4·1in. by 2·7in.

Apteryx haasti, Potts. (Haast's Kiwi.)

Two eggs of this rare form were collected by Mr. Charles Robinson on the Heaphy Ranges, on the west coast of the South Island. The larger of these, measuring 5·125in. by 3·125in., was taken, in a perfectly fresh state, on the 20th December, with the female bird, under a grass tussock. The male bird was found by the dog, also under a grass tussock, some distance away. The other egg, which is about one-eighth of an inch shorter, was taken (with a single bird in the nest) on the 26th January. It unfortunately got cracked through the struggles of the captive bird, and was found to contain a well-advanced embryo. Both eggs when taken were much soiled by contact with the birds' feet, especially the one that had been long incubated; but, on being washed, they disclosed a shell of a pale greenish-white. In form they are broadly ovoido-elliptical, the smaller one being almost a perfect ellipsis. These unique specimens are now in the Rothschild Museum, at Tring.

Art. V.—*On a New Species of Fern-bird* (Sphenœacus) *from the Snares Islands; with an Exhibition of Specimens.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 25th July, 1894.*]

I have much pleasure in exhibiting this evening some specimens of a new bird, which I have distinguished as *Sphenœacus caudatus*. In order to secure the advantage of early publication, I have sent my diagnosis of this species to our London ornithological magazine, the *Ibis;* but, as I think it well to have everything of the kind on record in the "Transactions of the New Zealand Institute" for the convenience of local workers, I append a copy of that paper.

In a collection of birds made for me by Mr. H. H. Travers on the last visit of the Government steamboat "Hinemoa" to the various groups of islands adjacent to New Zealand, there are a good many specimens of the Fern-bird or Utick, obtained by him on the Snares, a group of islets lying about seventy miles south of the southernmost extremity of New Zealand. I have hitherto referred this island-form to Mr. G. R. Gray's *Sphenœacus fulvus*. But the opportunity of examining so good a series (both male and female) has led me to investigate the subject further, and I am now satisfied that the species is distinct.

Mr. G. R. Gray's description of *Sphenœacus fulvus* appeared in his very useful "List of the Birds of New Zealand and the adjacent Islands" which came out in the *Ibis* of 1862.

To commence with, his bird was from New Zealand; and, although no locality is given, it cannot have come from the Snares, inasmuch as there was no communication with these small islands at that time.

According to his description, *Sphenœacus fulvus*, although of a "rather larger size" than *Sphenœacus punctatus*, has a smaller bill and shorter tail. This is not the case with the bird from the Snares, which is altogether appreciably larger, the bill being more robust, and the tail so conspicuously different that I have named the species from that feature: that is to say, instead of its being composed of Emu-like feathers with disunited barbs, the webs are closely set and compact, not differing in any way from the typical tail-feathers of the extensive family to which this genus belongs. Mr. Gray says of his bird that "the black streaks and dots are less pronounced than in *Sphenœacus punctatus*," which is not true of this bird; and he adds that "the abdomen is white, more or less minutely dotted with black," a description which is

equally inapplicable to this species. In Mr. Gray's bird the white superciliary streak is more pronounced than in *Sphenœacus punctatus;* in this species it is less so.

The form which I am now distinguishing appears to be intermediate between *Sphenœacus punctatus* of New Zealand and *Sphenœacus rufescens*, mihi, of the Chatham Islands; and its occurrence on the Snares is the more interesting as another inhabitant of these islets is the Chatham Island Robin (*Miro traversi*, mihi), which has never yet been found in New Zealand.

Sphenœacus caudatus, sp. nov.

♂ ad. similis *S. punctato*, sed paullo major: ubique lætius fulvescens, plumis vix ita distincte medialiter lineatis: pectore etiam minus distincte maculato: remigibus rectricibusque ochrascenti-fulvis; caudâ minus acuminatâ, scapis plumarum haud nudis, sed ad ipsum plumiferis. Long. alæ 2·65, caudæ 3·5, rostri 0·5, tarsi 0·85.

♀ mari similis.

Hab. Inss. Snares, maris Novi-Zelandici.

This is the *Sphenœacus fulvus* of my "Birds of New Zealand" (2nd ed., vol. ii., p. 61). The specimens therein referred to as having come from the South, without any locality being assigned, must, I now feel assured, have come from the Snares. They reached me through dealers, and it is almost impossible in such cases to get reliable particulars of the kind.

Art. VI.—*Notes on the Flightless Duck of the Auckland Islands* (Nesonetta aucklandica).

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S., &c.

[*Read before the Wellington Philosophical Society, 25th July, 1894.*]

I have lately had an opportunity of examining a large series of skins of the small Flightless Duck (*Nesonetta aucklandica*) collected by Mr. H. H. Travers at the Auckland Islands, to which this species is strictly confined. The sexes in the adult state do not differ much from each other, both exhibiting the delicate reflections on the plumage of the upper surface; but the male may be distinguished by its darker head and neck, by the black under tail-coverts, and by a greater abundance of vermiculated markings on the sides of the body. The young male, as I discovered, has exactly similar plumage to the adult female, the head being of the same brown colour as

the body, with a paler throat. There is likewise an absence of black on the under tail-coverts. The adult plumage is probably assumed in the second year. As with the insects of Madeira, mentioned by me in a former paper, so with this Duck: long disuse has rendered the wings useless for purposes of flight; but, as if to compensate for this, the species possesses the unusual faculty of being able to climb—an accomplishment which no doubt would be of far more advantage to the bird in its rocky habitat, surrounded by the ocean, than the power of flight. I made the discovery by the purest accident. Captain Fairchild, on the return of the "Hinemoa" from her last visit to the Auckland Islands, presented me with a live pair, which I at once placed on the Papaitonga Lake, in the hope that they might breed there. I afterwards purchased a pair from one of the crew, and, being desirous of sending these to Europe, I placed them in a wire enclosure, over 3ft. high, in a secluded part of my garden. I noticed that they at once commenced to scale the perfectly upright netting, falling back into the yard as they neared the top of the fence. Never supposing that they would get over the fence, I left them in the enclosure. In the morning the male bird, being the more robust of the two, had made its escape, and I had little hope of ever seeing it again, there being much close covert in the garden. A few evenings afterwards I found both birds again in the yard, the fugitive having evidently climbed back into the enclosure for the purpose of sharing his mate's food. In the morning he had disappeared again. This continued for about ten days, the bird (which is semi-nocturnal in its habits) skulking and hiding during the day, and coming back in the evening to share the food. When I was ready to ship the Ducks I had simply to visit the enclosure after dusk, and then, catching them without difficulty, they were cooped and despatched to London by the R.M.S. "Tainui."

Art. VII.—*Notes on* Phalacrocorax colensoi, *of the Auckland Islands, and on* Phalacrocorax onslowi, *of the Chatham Islands.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 5th September, 1894.*]

Mr. H. O. Forbes, in his paper "On the Birds inhabiting the Chatham Islands," which appeared in the *Ibis* for October, 1893, describes, under the name of *Phalacrocorax rothschildi*, a Shag found at the Chatham Islands and in the

south of New Zealand, separating it from *Phalacrocorax colensoi*, and saying, "This species is distinguished at once by the approximation of the dark plumage of the head beneath the throat, leaving a comparatively narrow white stripe between them." He also makes the possession of both the white alar bar and the white dorsal spot characteristic of his new species.

In my opinion we have a good deal more to learn about the Shags inhabiting New Zealand and the adjacent islands; and I think Mr. Forbes was somewhat rash in characterizing this as a new species without further investigation.

The type of my *Phalacrocorax colensoi* was from the Auckland Islands, but (like all the other specimens collected there by Mr. Burton at a wrong season of the year) it was in old and faded plumage, with dingy colours. Quite recently, however, I have had an opportunity of examining a large number of skins in good plumage, collected by Mr. Henry Travers at the Auckland Islands and on Campbell Island during the last cruise of the Government gunboat "Hinemoa." The examination of this collection has satisfied me that Mr. Forbes's "characters" are of very little value. The form and width of the white stripe down the foreneck, the presence or absence of the alar bar, and the dorsal patch of white, are inconstant features, due apparently to age or season. It will probably be found, when we become better acquainted with the species, that the bird is carunculated at one season of the year and not at another, for all the specimens brought by Mr. Travers (killed in May) are without caruncles on the face. They include adult birds of both sexes, but presenting very different phases of plumage. In three of them there is a slight coronal crest, the feathers being acuminate, and produced beyond the ordinary plumage of the head. In some the alar bar is very conspicuous, occupying the whole of the median wing-coverts, in others it is broken and irregular; in one of the birds it is wholly absent, whilst in another the only indications of it are a few scattered white feathers among the dark wing-coverts. Of the whole series only one presents the white dorsal spot. The white throat-stripe is very uncertain in character: in some of the specimens it widens gradually from the chin to the breast, whilst in one of them it is narrow and of even width in its whole extent; in some it is constricted in the middle; and in one of them the dark plumage of the sides of the neck almost meets above the breast, the white stripe being interrupted and broken. Out of the whole lot only one gives the wing-measurement of my type—namely, 10·5in. In all the others the wing, from the flexure, measures 11in. It will be seen therefore that, even in this respect, the species is variable. The fact is that this Shag, like many others,

varies with age and season, and the only thing to be done, so far as I can see, is to make the characters of *Phalacrocorax colensoi* somewhat wider.

In a specimen which I have since had an opportunity of examining the dark plumage actually meets about the foreneck, there being only a few minute white feathers along the line of junction. There is a single lengthened coronal feather, evidently the vestige of a crest that had recently been shed. There is a broad alar bar of white, but no dorsal spot. This bird, which presents old and faded, or out-of-season, plumage, was obtained by Mr. Henry Travers on a former visit to the Auckland Islands, about the year 1890.

With regard, however, to another species of Shag Mr. Forbes has, I think, been more fortunate. He is probably right in considering *Phalacrocorax imperialis*, with which I had united the Chatham Island Shag, as being confined to the Straits of Magellan, from whence the type came. I am perfectly sure that the Chatham Island bird is distinct from *Phalacrocorax carunculatus* of New Zealand, and if it cannot properly be united with *P. imperialis* it requires a distinctive name; and in providing this Mr. Forbes could not, in my opinion, have made a better selection than he did in dedicating this handsome species to our late Governor. Lord Onslow not only took an active interest in our native birds and their preservation, but he was the first to send to Europe living specimens of *Phalacrocorax carunculatus*, one of which, I believe, still survives in the Zoological Society's Gardens at Regent's Park.

The beautiful example of *Phalacrocorax onslowi* which I have the pleasure of exhibiting to you to-night came, I presume, from the Chatham Islands, although I have no information of locality with it. The specimen is in brilliant plumage, and if you will handle it you will find the feathers of the neck as soft and yielding to the touch as the finest silk-velvet. It is a male bird in full breeding plumage, and has a superb coronal crest, the feathers composing which are from one to three inches in length, of narrow even breadth, and of the same brilliant metallic blue as the surrounding plumage. Mr. Forbes, in diagnosing the character of this species, includes "an alar bar and doubtfully a dorsal spot of white as it is absent in the specimens, though mature and crested, described and figured by Sir W. Buller." On examining the specimen now before the meeting, you will observe that, although apparently in the most matured plumage, the neck being adorned with white hair-like filaments an inch long and the alar bar being very conspicuous, there is not the slightest indication of the dorsal spot of white. I think we may conclude that its absence is characteristic of the species.

P.S.—Since the above was written I have had an opportunity of examining some further specimens of *Phalacrocorax carunculatus* from the White Rocks, Queen Charlotte Sound, the only locality in New Zealand, so far as we are aware, in which this species is to be found. Captain Fairchild informs me that there is still a small colony of these birds, numbering from fifteen to twenty, breeding on the rocks. On the occasion of his visit last week he found the young hatched out, but still occupying the nests. Four of these, of different sizes, clothed in thick down, he brought over with him in the "Hinemoa," and I have sent them up to the Papaitonga Lake, where I trust they will thrive and ultimately breed. Two old birds, both females, were shot by the crew and the skins preserved. I had an opportunity of examining one of these. The pad of orange caruncles on the brow, on each side of the head, is very prominent, and as it is entirely absent in some examples I take it to be a feature peculiar to the breeding-season. There is no appearance whatever of a crest, or even an elongation of the coronal feathers. The white alar bar is very conspicuous; so is the dorsal double patch of white. The naked space around and in front of the eyes is entirely dark-blue; and the feet are flesh-coloured.

Nestling.—Covered with sooty down. Fore part of head, face, and throat, perfectly bare; the skin, which is jet-black, presenting a granulated surface, and having the appearance of kid-leather. Upper mandible brownish-black; the under mandible, except at the tip, as well as the skin at its base, in a straight line from the angle of the mouth, bluish-white, the black colouring of the skin beyond, however, being continued, in a tapering streak, to a point within the rami. Under each eye there is a minute round spot of white. Legs and feet dark-grey, the webs lighter.—W.L.B. Wellington, 25th September, 1894.

Art. VIII.—*Note on* Œstrelata neglecta; *with an Exhibition of Specimens.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 5th September, 1894.*]

When I had the privilege of placing before you on the 25th July last a budget of ornithological notes I took occasion to refer to Professor Hutton's supposed new species of Petrel from the Kermadec Islands, to which he had given the name

of *Œstrelata leucophrys*, and, following Mr. Salvin, I then stated my belief that, instead of being a distinct species, it was only a form of *Œ. neglecta*. We have not had to wait long for confirmation of this view. I have the pleasure of exhibiting to-night a pair of birds kindly lent to me for that purpose by Mr. Bethune, the second engineer of the "Hinemoa." The male bird is in the plumage of Professor Hutton's *Œstrelata leucophrys*, whilst the female is in the ordinary plumage of *Œstrelata neglecta*. They were taken by Mr. Bethune himself from their breeding-burrow on Sunday Island. Indeed, Mr. Bethune assures me that on every occasion he can remember—and he has collected many of these birds in the breeding-season—he has found the two kinds mated and breeding together. From this it might be inferred that the difference of plumage is sexual. As against this view, however, I have to exhibit a specimen in an intermediate state of plumage, the sides of the head and neck being very prettily rayed with dusky grey; also an example with a still whiter head than Mr. Bethune's male bird presents. All this goes to prove the correctness of Mr. Salvin's contention as to the variability of this species in regard to plumage. It is perfectly clear, therefore, that *Œstrelata leucophrys* will not stand as a species.

At the same time that I submitted my specimens of *Œ. neglecta* to Mr. Salvin (as stated in my former paper, page 123) I showed him also a pair in entirely dark plumage, which seemed to me to be distinct, and which, in that case, I proposed to dedicate to Captain Fairchild, who has done so much to increase our knowledge of the birds inhabiting the outlying islands. Mr. Salvin expressed a strong belief that these were referable to the same species in a dark phase of plumage, and said that nothing would satisfy him to the contrary short of finding the dark-coloured birds nesting together apart from the lighter-coloured birds, and breeding true. I felt bound to defer to the opinion of a naturalist who has made the Petrel family his special study, so I abstained from recording this supposed new form. The two specimens which I exhibit to-night seem to prove that in this case also Mr. Salvin was right in referring the bird to *Œstrelata neglecta*. In one of them the entire plumage is brownish-grey, darker on the upper surface, changing to brownish-black on the wings and tail; the primaries, secondaries, and tail-feathers being white in their basal portion, with white shafts, darkening towards the tip. In the other specimen the under surface is much lighter, whilst on the throat there are indications of a change to the pale-grey characteristic of ordinary specimens of *Œ. neglecta*. I think, therefore, we may pretty safely assume that this is the young state of that species.

In Mr. Bethune's two specimens now exhibited the wing measures, from the flexure, exactly 11·75in.; in my intermediate example it measures 12in., and in the more matured one only 10·5in. In the two entirely dark birds the wing, as in the first-named, measures 11·75in. The dark birds have brownish-black legs and feet, whereas in all the others the tarsi are yellowish, and the toes "sandalled" with black; but this difference is no doubt due to the immaturity of the former.

Art. IX.—*Some Curiosities of Bird-life.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 19th September, 1894.*]

Pursuant to the title of my paper, I shall exhibit to you this evening some remarkable "freaks of nature," or curiosities of bird-life. One of them, as I shall presently show, is a pure albino Kiwi, of the small species known to us as *Apteryx oweni*, the ordinary plumage of which is of a speckled or dappled-grey colour. But before proceeding to the specimens I wish to say a word or two on the subject of albinism.

The inherent tendency to albinism is one of the distinguishing features of the New Zealand avifauna. Albinism in the human subject is due to the absence of the minute particles of colouring-matter in the epidermis or outer cuticle, the presence of which, in more or less abundance, gives colour to the skin. In many species of quadrupeds, birds, and reptiles, albinism, due to a precisely similar cause, often exhibits itself, the skin, hair, feathers, and also the hard tissues—even the horny sheaths and scaly coverings—presenting an abnormal whiteness. Sometimes, as in the case of white rats, mice, and rabbits, this is accompanied by an abnormal condition of the eyes, which become blood-red. The whiteness of plumage, the purity of which is regulated by the entire or only partial absence of the colouring pigment in the feathers, is thus easily accounted for; but I have been unable to discover any sufficient reason for the frequency of this condition of plumage among the birds of New Zealand. It is certainly not the result of disease, or of a low state of vitality, any more than albinism in the human subject can be taken to indicate an enfeebled condition of mind or body. May it not, then, be in some way dependent on climatal conditions? It is significant that in tropical India the tendency is in an

opposite direction, melanism, as we are informed, being of frequent occurrence there. Now, in the whole of my experience I have met with only two examples of melanism among New Zealand birds—the subjects being *Anthornis melanura* and *Miro albifrons*—and I cannot say that in either case was it very pronounced. Of albinism, however, in this country there are endless examples. In my "Birds of New Zealand" (2nd ed.) I have recorded albinoes, more or less perfect, of thirty-three species (see enumeration on page xlii. of Introduction). I have since recorded six more in the pages of our "Transactions"—namely, *Myiomoira toitoi*, *Halcyon vagans*, *Puffinus griseus*, *Diomedea regia*, *Diomedea fuliginosa*, and *Apteryx haasti;* and I am informed by the Hon. Walter Rothschild that he has received a pure albino of *Thinornis novæ-zealandiæ* from the Chatham Islands.

It is, of course, the pigments in the feathers which produce the colours that we admire so much. Dr. J. S. Kingsley, in an excellent article on the subject, informs us that "a colouring matter which is called zoomelanin, and thought to be identical with coriosulphurine, seems to produce all the black and dark hues in birds, while some green colours are due to an admixture of a yellowish pigment called psittacofulvine. A really green pigment has only been found in the touracoes, —hence the name turacoverdin,—and no blue or violet pigment has yet been discovered, while red (zooerythrine) is quite common. Another red, turacin, causes the magnificent red on the wings of the *Musophagidæ*. There is no white pigment, but wherever that colour occurs it is due to the countless number of interstices between the molecules of the feather, the substance of the latter being colourless. Many tints—for example, blue, violet, and certain greens—are not due to the pigment, which is black-brown to yellow, but the blue results from a particular surface-structure of the feathers, so that it must disappear if the colour-producing parts be destroyed. Thus, if we hammer carefully the deep-blue feathers of a Macaw, the blue colour immediately disappears, and the injured part looks grey or brownish, according to the underlying pigment. Some green parrot-feathers, when treated in a similar way, become yellow, since this is the colour of their pigment." We are told that the gloss of feathers, independent of the colour itself, is the result of their surface being smooth and polished, while the metallic lustre is due to a transparent sheath which acts like a prism.

Closely connected with this subject is that of "dichromatism." Of this colour-problem the same author says, "We are accustomed to call it dichromatism, but of its true nature and its significance in the animal economy we are quite ignorant. By this term we designate the peculiarity, in certain

species of birds, that individuals present two different styles of coloration, or 'phases,' presumably more or less independent of geographical distribution, present or past, or, in fact, of any apparent cause whatsoever. The difficulty in finding a plausible theory is much increased by the circumstance that there are nearly as many kinds of dichromatism as there are dichromatic species." Among the examples put forward by him is that of the dark and white forms of *Ossifraga gigantea*. In this I think he is mistaken. I have, from time to time, recorded seven examples of the White Nelly from New Zealand waters. Of these only two were absolutely pure albinoes. One of them, which I obtained at Waikanae, about forty miles up our west coast, and presented to the Colonial Museum, was of snowy whiteness, without blemish of any kind, even the legs and feet being whitish, whilst the bill was yellowish horn-colour. The other, which is almost as pure, was obtained at sea, about ten miles north of Milford Sound, and presented to me by Captain Fairchild. All the other examples are more or less marked with dark feathers, scattered irregularly over the entire body. There are certainly two phases of the dark plumage—the one uniform slaty-grey, the other paler grey with whitish cheeks and throat—but these differences are in my opinion attributable to age and sex.

In addition to "dichromatism" there is what is termed "trichromatism," where, apart from the normal form, there are two different-coloured phases, although this phenomenon appears to want confirmation, the evidence in support of it being incomplete. If the theory be true it may help to explain the formation of new species,—the original stock dying out in the struggle for existence, and the dichromatic phases becoming stereotyped into two invariable forms or species, separated geographically but still identical in structure. Dr. Kingsley mentions an example brought forward by Mr. Ridgway, that of the Scarlet and the White Ibises (*Guara rubra* and *G. alba*), of which he remarks that they are now so different in colour that probably no one would deny their specific distinction, though structurally so alike that a specimen of the white one dyed scarlet would be indistinguishable from *G. rubra;* and he concludes with this observation: "The question which finally impresses itself upon the inquirer, in view of the above facts, is this: Are not the two or three phases of dichromatic or trichromatic species 'incipient species,' the final state of which will be that of the White and the Scarlet Ibises? The subject is one of the most perplexing, and consequently most interesting, questions in modern ornithology. It shows what we know, and particularly what we do not know; it shows that ornithology means more than a mere description and naming of birds; that one of its aims is to contribute to

the solution of the great problem of the age—'the origin of species.'"

There is another point on which I should like to say a word before exhibiting the specimens. I have recorded only five perfect albinoes of *Apteryx oweni* and one case of partial albinism.* It will be seen therefore that this condition of plumage is a rarity. I do not hesitate to say, however, that in a few years' time a specimen of the Grey Kiwi in the ordinary plumage will be as rare in New Zealand as the abnormal example I am presenting to you to-night; and I will tell you why. Not many years ago this species existed in great abundance in certain parts of the South Island. It was of course to be expected that a bird incapable of flight and devoid of any means of self-defence would diminish in numbers as the country became settled, and dogs and cats, running wild, spread themselves over the interior; but a new factor has come into existence which threatens the speedy extermination of not only *Apteryx oweni* but of many other indigenous forms. I refer to the introduction, at the instance of a former Government, of polecats, stoats, and weasels. From a naturalist's point of view, I regard this act in the light of a crime. The vermin that every farmer in the Old Country was trying to extirpate as an unmitigated evil our wise Government bought up by the hundred and imported into this country, in the vain hope that these "carnivorous beasts" would change their habits and take to a rabbit diet, to the exclusion of everything else! No doubt, to abate the rabbit-nuisance, which was causing widespread loss and even ruin to our sheepfarmers in many parts of the country, was a most desirable object. But it is a question whether, in the introduction of polecats, stoats, and weasels, the Government was not establishing, even from the farmers' point of view, a still greater evil. As shipment after shipment of this vermin from over the water arrived in New Zealand, I raised my voice in protest against so insane a policy, and so did others—notably Professor Newton of Cambridge—but all to no purpose. The imported animals were turned loose north and south, and have now become firmly acclimatized in a country where the conditions of life are so favourable to their existence that no power on earth will ever dislodge them. The Wairarapa was the principal seat of the rabbit-plague in this provincial district; so the destroyers, of whom so much was expected, were liberated there. But they did not stay long with the rabbits. Swarming over the dividing-range, and crossing in summer the snow-capped ridges of the Ruahine, they descended upon the fertile lands of the west coast, where they are now fairly established,

* "Birds of New Zealand," 2nd ed., vol. ii., p. 328.

and where there are practically no rabbits for them to prey upon. They are making themselves felt, however, in other respects. The rabbits devastated the pastures, but they left the sheep alone. Not so with these "Government immigrants." One farmer at Kereru complains that in a single night this season he lost forty lambs, each exhibiting a small punctured wound, betraying the depredator. My sons had their hen-roost visited at night, and a brood of valuable fowls destroyed. The breeding of turkeys was at one time a profitable industry in these districts, the hen-birds forming their nests in the scrub and along the outer edges of the bush; but, with these marauders abroad, a turkey has now very little chance of bringing out a brood. Formerly, the Woodhen (*Ocydromus greyi*) was very abundant in the Horowhenua and Manawatu districts, its loud and not unmusical whistle being heard on all hands as the shades of evening deepened into the gloom of night. Now all this is changed. The responsive cries of the Woodhen are seldom heard, and there is nothing to break the stillness of the night but the call of the Morepork keeping his vigils. The diminution in numbers of our introduced game—Pheasants and Californian Quail—must, I think, be attributed to the same cause.

Mr. Jonathan Brough, writing to me from the Pelorus, says, "I have now been camped in these woods for about a month—up one of the tributaries of the Pelorus River known as Wakamarina. I am camped a long way up the creek, at a place where I used to collect birds some years ago. In those days I found this a good hunting-ground; a great number of species could be then obtained in this locality; but now all this is changed. I seldom see or hear any birds worth collecting. The stoats and weasels have done their work. For three weeks I was camped right up amongst the mountains and in the heart of the bush, and I never saw a single Woodhen, nor did I ever hear one. I heard one Kiwi calling, and I found one dead on the ground with its head and neck mutilated by the stoats. I do not now see or hear any Saddlebacks, or Pigeons, or Wrens, all of which were plentiful enough in this place a few years ago. The Blue Duck used to be fairly abundant in the creek, and they are now nearly extinct. This time I have seen only one pair. They had a brood of young ones, so I felt that I could not shoot them. They had six young ones when I first saw them. I have an opportunity of seeing them in the creek every day, and it is very interesting to watch them. But the young ones are getting fewer every week, and now there are only three left. I attribute this also to the stoats, which are very numerous about here. Collecting specimens of natural history in this

part of the country is a thing of the past, for the stoats and weasels have swept away everything."

An old settler at Wanganui, from whom I have received many specimens in the past, writes me: "Weasels have destroyed all game, and I think Wekas will share the same fate. I never see any. I have killed seventeen weasels on my place in three months; and of the many bad things introduced I think this the worst." And Mr. William Smyth, the well-known collector, writing to me from Dunedin, says, "I got only a few Wekas from Waimate last winter. They have practically disappeared from the Otago country."

Even the country babies appear to be scarcely safe, for a paragraph has appeared in one of the newspapers stating that a child playing on the open common at Palmerston North was attacked by a pack of four stoats, and narrowly escaped serious injury.* Whether this report was true or not I cannot say, but it is just what is likely to happen when the bloodthirsty animals become numerous enough. Side by side with this wicked introduction into our fair country of animal pests we have the reckless—and, to my mind, ignorant—practice on our sheep-farms of poisoning hawks. There can be no doubt that the Harrier (*Circus gouldi*) does occasionally attack weakly lambs, tearing out their eyes and causing their death. So, for that matter, does the large Seagull (*Larus dominicanus*). But it is much easier for a hawk to attack and prey on a young rabbit than on a lamb; and, as a matter of fact, we owe to this cause that the rabbit, although it became established on the sandhills of the west coast of this province some twenty years ago, has never been able to sweep the country as it has done elsewhere. The conditions for hunting it on the open sandhills are favourable to the Harrier, and the bird has effectually kept the rabbit-nuisance under. I have always said that it is a dangerous thing to disturb the balance of nature; and I am persuaded that on our west coast at any rate the farmers who sometimes poison with strychnine twenty or more hawks in a week do themselves far more harm than good. But that is an evil of far less magnitude than the one we have been discussing—the introduction of polecats, stoats, and weasels. The Minister who, in the excess of his ignorant zeal, authorised this public expenditure will probably be remembered in the colony long after we are dead and gone.†

---

* See Trans. N.Z. Inst., vol. xxiv., p. 90.

† Since the above was written it has been officially notified in the Government *Gazette* that ferrets, stoats, and weasels are protected by law! As a fitting commentary upon this the following paragraph appeared a few days later in the *New Zealand Times*: "Stoats are reported to be very troublesome in the Hawera district. One settler reports that sixteen eggs out of eighteen were destroyed in one nest by stoats last week." And a

It is melancholy to reflect that the New Zealand avifauna, which had already, from a variety of adverse causes, become endangered, should be thus subjected to an overwhelming influence for evil. But for this unfortunate introduction there would have been some hope of many of the species being permanently preserved. Indeed, it had become a subject of remark that such birds as the Woodhen, the Swamp-hen, and the Banded Rail were becoming more numerous in all the cultivated districts, the conditions of existence being more favourable. To show you that I am not raising an unnecessary wail over the birds that are vanishing, I will quote a passage from Professor Newton's admirable article on "Birds" (Enc. Brit., p. 742):—

"As a whole, the avifauna of New Zealand must be regarded as one of the most interesting and instructive in the world, and the inevitable doom which is awaiting its surviving members cannot but excite a lively regret in the minds of all ornithologists. This regret is quite apart from any question of sentiment; if it were otherwise, it could not be defended against that sentiment which prompts our colonial fellow-subjects indiscriminately to stock their fields and forests not only with the species of their Mother-country, but with all the fowls of heaven, whencesoever they can be procured. The regret we express arises from the thought that, just as we lament our ignorance of the species which in various lands have been extirpated by our forefathers, so our posterity will want to know much more of the present ornis of New Zealand than we can possibly record; for no one nowadays can pretend to predict the scope of investigation which will be required, and required in vain, by naturalists in that future

correspondent of the *Evening Post*, under the *nom de plume* of "Bushman," commenting on the *Gazette* notification, writes, "I should like to know when this craze of a few faddists is going to cease, for it seems to me about time that some one entered a strong protest against the wholesale introduction of these pests into our beautiful adopted country. Any one who, like myself, has kept ferrets for years must know that the habits of the animal are entirely against its ever doing any real good as an exterminator of rabbits, for, unlike a cat, a ferret will not hunt for the sake of hunting; and, as it almost always lays up and sleeps for two or three days after a heavy meal, this must militate against its usefulness. Again, ferrets and their congenitors will hardly ever touch fur if they can obtain feathers, which is the reason that in many districts where pheasants and quail were once plentiful they are now nearly extinct. And the last but greatest evil is that ferrets are, and have been for years, killing hundreds, and I might say thousands, of lambs yearly all over the country. Now, I would ask, is it any use proclaiming such vermin as 'protected animals,' when the above facts are well known? Is it not merely inviting people to break the law? I have for years killed every ferret, stoat, or weasel that I could get a chance at; and many others that I know do the same, or we should have long since been plagued by a worse pest than the rabbits ever were."

when New Zealand may be one of the great nations of the earth."

Without further preface I shall invite your attention to the three very interesting specimens on the table, about each of which I have a few remarks to offer.

1. **Nestor meridionalis,** Gmelin. (Kaka.)

Mr. Gould, in the supplement to his superb work on "The Birds of Australia," figures and describes several species from New Zealand. Among these there is the Prince of Essling's Parrot (*Nestor esslingii*, De Souance), upon which he remarks as follows:—

"A single specimen only of this magnificent Parrot has come under my notice; and this example is perhaps the only one that has yet been sent to Europe. It formerly formed part of the collection of the Prince d'Essling of Paris, but now graces the National Museum of Great Britain. It is in a most perfect state of preservation, and is, without exception, one of the finest species not only of its genus, but of the great family of Parrots. The native country of this bird is supposed to be New Zealand; but I, as well as M. de Souance, have failed to learn anything definite on this point. In size it even exceeds the great Kaka (*Nestor meridionalis*), which it resembles in the form of the beak, while in its general colouring it closely assimilates to the *Nestor productus;* in some features of its plumage, however, it differs from both. In both those species the tail-feathers are strongly toothed on the under surface with red; and in the *N. esslingii* no such marks occur, the toothing on the inner webs of the primaries is not so clear and well defined, and the light-coloured interspaces are much freckled with brown."

Dr. Finsch, on the other hand, states in his "Monograph of Parrots" that *Nestor esslingii* is in size and general colour the same as *Nestor meridionalis*, but "has the breast ash-grey with brown terminal margins, and a broad yellowish-white transverse band straight across the belly." He quotes De Souance to the effect that the red marks on the inner vane of the quills and tail-feathers are precisely as in *Nestor meridionalis*.

As far back as 1870 I expressed my belief that this was only an accidental variety of our common *Nestor meridionalis;* and a subsequent examination of the specimen in the British Museum, on my first visit to England, confirmed this view. At this time the specimen was exhibited, mounted with others of the same genus, in a plate-glass show-case in one of the main galleries. But Dr. Bowdler Sharpe, the able Curator in charge of the collection of birds, has had them carefully unmounted and reduced to the condition of cabinet skins, as

he feared that constant exposure to the light would have a damaging effect on the bright plumage. In the "Bird-room," however, they are always accessible to students, and may be examined with more satisfaction than in hermetically-sealed show-cases.

The specimen which I have the pleasure of exhibiting to-night is, so far as I can remember, almost exactly similar to the type of *Nestor esslingii*. There is a very slight indication of the toothed markings on the under-surface of the tail-feathers; but, as I have already shown, the authorities differ as to their presence or entire absence in the original specimen. The curious part of the story, however, is that the bird now exhibited is one of three, all marked alike, recently obtained in the same locality (District of Marlborough)—all three of which I have had an opportunity of examining. One would have felt much inclined to rehabilitate *Nestor esslingii* as a species but for the fatal circumstance that one of them has the lower mandible on one side yellowish-white, betraying the latent tendency in the bird to albinism. I still feel satisfied, therefore, that this handsome bird is only a variety of *Nestor meridionalis*, the most variable of all our indigenous Parrots.

2. **Stringops habroptilus**, Gray. (Kakapo.)

I have described in "The Birds of New Zealand" (vol. i., pp. 177–78) several remarkable varieties of this bird, the tendency generally being towards a more or less yellow plumage. The bird exhibited this evening is no exception to that rule. It is paler-coloured than any specimen I have hitherto seen, the entire under-surface being dull lemon-yellow clouded with obscure green and brown, the upper parts much suffused with yellow, the tail-feathers clear lemon-yellow with black shafts and obscurely barred and toothed with brown, the primaries lemon-yellow and the secondaries greenish-yellow, with similar blackish-brown markings to those of the ordinary bird.

3. **Apteryx oweni**, Gould. (Grey Kiwi.)

This bird is the nearest approach to a perfect albino that I have yet met with among individuals of this species, there being only a tinge of yellowish-brown on the plumage of the upper surface. As already mentioned, I have recorded five albinoes, all more or less stained with yellow or brown, and one partial albino, presenting only irregular patches of white. This specimen was received from Canterbury; so also were the other two birds described above.

Art. X.—*On the Wetas, a Group of Orthopterous Insects inhabiting New Zealand; with Descriptions of Two New Species.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 19th September, 1894.*]

In Gray's "Zoological Miscellany," 1842, p. 78, there first appeared a description of the great forest Weta of New Zealand, under the name of *Deinacrida heteracantha*, White. A further account of this remarkable insect was given in the List of the Fauna appended to Dieffenbach's "Travels in New Zealand," from which I extract the following: "The length of the specimen brought by Dr. Dieffenbach, measuring from the forehead to the end of the abdomen, exclusive of appendages, is 2in.; from the end of the tarsus of hind leg to end of antenna stretched out, this specimen measures at least 12½in. The specimen may be in the larva state. The præsternum, as in Anostostoma, with two spines approximating in the middle; meso- and meta-sternum deeply grooved behind, with a strong tooth on the sides behind. Dr. Andrew Sinclair, since my short description was published in the second part of Mr. Gray's Miscellany, has brought from New Zealand a specimen of this species which, with its hind legs and antennæ stretched out, is at least 14in. long; its head and body, exclusive of appendages, being 2½in. The specimen is a female; its ovipositor is rather more than 1in. long, is slightly bent upwards and compressed through the greater part of its length, the two cultelli forming its principal part being somewhat angular at the base. Nearly the whole insect is of an ochry-yellow colour, the end of the ovipositor and the extreme tip of the spines on the legs being brown; the margins of the abdominal segments are of a lighter colour; the transversely-ridged and rough-surfaced femora have many light-coloured streaks. The greater portion of the dorsal part of the thorax is somewhat ferruginous. This specimen was found by itself on the marsh-pine in Waiheke, in the Firth of the Thames. Five other specimens of smaller size Dr. Sinclair found congregated under the bark of trees."*

The last-mentioned specimens belonged, no doubt, to the species afterwards described as *Deinacrida* (*Hemideina*) *thoracica*, White (Voy. Ereb. and Terr., Ins., 1846).

---

* *Op. cit.*, vol. ii., p. 280.

In 1867 I published in the "Zoologist," page 850, the description of a new species, *Hemideina megacephala*, Buller, distinguished by its enormous head.

In 1869 ten more names were added to the group, namely: *Hemideina producta* (afterwards referred by Professor Hutton to *H. thoracica*),* *H. capitolina*, *H. figurata*, *H. abbreviata*, *H. tibialis*, *Ceuthophilus* (?) *lanceolatus*, *Macropathus filifer*, *M. fascifer*, and *M. altus* (White, Cat. Locustidæ); also *Hadenœcus edwardsii* (Scudder, Proc. Boston Soc. of Nat. Hist., xii., p. 408).

In 1870 I communicated a paper to this Society (Trans. N.Z. Inst., vol. iii., pp. 34–37) in which I republished my account of *Hemideina megacephala*, and described a new species under the name of *Deinacrida rugosa*, Buller (with figures of both).

In 1880 Mr. Colenso described (Trans. N.Z. Inst., vol. xiv., p. 278), under the name of *Hemideina gigantea*, "a species bigger in every way than *D. heteracantha*," adding, "it is also much more spiny, and differs greatly in colours," &c. He at the same time described (*tom. cit.*, p. 240) another species, *Hemideina speluncæ*, giving as its habitat "dark underground caves near the head of the Manawatu River, in the Forty-mile Bush."

Respecting the first-named of these Mr. Colenso gave some very interesting historical particulars.

An admirable figure of *Deinacrida heteracantha* appeared in the "Zoology of the 'Erebus' and 'Terror,'" part "Insects," p. 24, pl. 5, fig. i.; and in 1868 Professor Hochstetter published a good figure in outline ("New Zealand," p. 170), with a brief and somewhat inaccurate account of the insect, concluding with this remark: "Despite its hideous looks it is perfectly harmless."

Mr. Colenso stated in 1880 (*l.c.*, p. 280) that his unique specimen of *Hemideina gigantea* had then been forty-two years in spirits with its colours unaltered, the liquid in the glass bottle containing it being still clear and pure. To this we must now add thirteen years more; so that the specimen has been canonized for more than half a century. I think the beautiful female specimen of *Deinacrida heteracantha* in my son's collection can show almost as good a record. It is amongst the earliest recollections of my life that, about forty-five years ago, wandering through the woods at Tangiteroria with my private tutor, Dr. Beard, we found this huge Weta at the foot of a tree, and brought it home in a silk pocket-handkerchief. Being something of a naturalist, the doctor care-

* "Catalogue of the New Zealand Diptera, Orthoptera, Hymenoptera," 1881, p. 82.

fully stuffed the insect and placed it in a small glass show-case of his own construction, where it has remained hermetically sealed ever since. It had perhaps a better chance than the specimen in spirits of preserving its colours, and it is now as fresh and bright as the day it was stuffed. I remember that some years later, in riding through a strip of bush between Mangakahia and Whangarei, I caught a pair of them on a low tree, where they were apparently feeding on the young leaves. Dismounting from my horse, I secured the two Wetas in a pocket-handkerchief, and hung them up in a tree to await my return a day or two later. On coming back, however, I found that they had eaten their way out and made their escape.

For many years this fine insect has been looked upon as extinct, and it certainly is extremely rare; but since my last return from England I have been fortunate enough to secure the large male specimen now on the table. I purchased it from a dealer in Auckland, who told me he had procured it from one of the small wooded islands in the Hauraki Gulf. Formerly it was very abundant in all the woods at the far north; but I never heard of its being found south of the Waikato district. The Maoris attribute its disappearance to the introduced Norway rat. They distinguish it as the Wetapunga.

In 1884 Mr. Colenso (*op. cit.*, vol. xvii., p. 155) added another species, under the name of *Deinacrida amiger*, from Wairoa, Hawke's Bay District, stating that it seemed allied to *H. megacephala*. In 1886 he described (*op. cit.*, vol. xix., p. 145) *Hemideina longipes*, from a specimen obtained in a totara forest at Norsewood, in the County of Waipawa. Finally, in 1888, he described, under the name of *Hemideina nitens*, "a peculiar species, differing from other described ones in its general very dark colour, extreme glossiness," &c.

It will be seen, therefore, that Mr. Colenso has added no less than five species to the list. I have not had an opportunity of examining any of his types, and cannot therefore express any opinion as to the value of his specific characters. After a careful study, however, of his descriptions, I am satisfied that none of them apply to the fine insect which I have the pleasure of exhibiting to-night, and for the loan of which I am indebted to Mr. Teutenberg, of Auckland. He informed me that he obtained it at Coromandel, but he could give me no particulars respecting it. Judging by its character, I should say it is an inhabitant of caves or overhanging rocks.

Genus Macropathus, Walker.

Group 4.

Macropathus maximus, sp. nov.

Male.—Body stout, convex, smooth, not shining. General colour rich tawny-brown, darker on the joints, and deepening

to reddish-brown on the hind tibiæ; changing to yellow on the face, front tarsi, and greater part of antennæ. Head short, fore part vertical. Eyes prominent, rounded, and blackish-brown in colour, as is also the slightly-polished vertex. Maxillary palpi long and slender; the fourth joint somewhat longer than the third; the fifth appreciably longer, and distinctly subclavate. Labrum prominent; labial palpi clavate at the tip. Antennæ extremely long and slender, being more than six times the length of the body; the first joint much thickened, the rest smooth and even, being entirely free from the minute knobs and spines that occur on the antennæ of *Macropathus fascifer*. Prothorax well covered with shield, which is broadest behind, the lower border being slightly reflexed. Mesothorax and metathorax presenting broad, even segments; the eight abdominal dorsal segments much narrower, closely set, and gradually diminishing in size towards the extremity; cerci of moderate length and beset with fine hairs, especially towards the base. Abdomen short, slightly compressed. Legs slender, extremely long, and very spiny; hind femora greatly swollen towards the base; knees nodose. The four anterior femora have spines beneath, but the number is uncertain: thus, of the first pair the right-hand femur has four spines, and the left-hand femur five spines; of the pair behind, the right femur has two on one side and five on the other, whilst the left femur has three on each side; the hind femora, on their channelled posterior surface, have twelve to thirteen sharp spines, set well apart, on one side, and twenty-three to twenty-five small closely-set ones on the other side. So also with the tibiæ: the first pair have each five extremely fine spines, or rather spurs, on each side, the apical ones being the longest; of the next or middle pair the right-hand tibia has three on one side and four on the other, whilst the left-hand tibia has three on one side and two on the other. The hind tibiæ are armed with a regular double series of sharp, slightly-decurved spines, exactly resembling the thorns on a rose-bush, those towards the base being extremely minute, and the apical or terminal ones very long; the right-hand tibia has twelve on one side and fourteen on the other, whilst the left-hand tibia has twelve on one side and eleven on the other. It will be seen, therefore, that the number of spines is a very uncertain character. The body, without the appendages, measures exactly 1in. in length and 0·4in. in its widest part; the hind femora measure 2in., and the hind tibiæ 2·25in.; the cerci, which are slightly curved upwards, measure 0·3in.; and the antennæ 6·25in.

I have made this Weta the representative of a fourth group of Walker's genus *Macropathus*. It may, however, be necessary to make it the type of an entirely new genus. It differs

from the typical *Macropathus* in having a dull or plain, and not a shining, surface; and, like *Deinacrida*, it has ten dorsal segments behind the thoracic shield, instead of eight as in *M. fascifer*. It has fine and slender antennæ, in which respect also it comes near to *Deinacrida;* it has numerous spines on the four anterior femora, whereas *M. fascifer* has only two; and, whilst the latter has only four or five minute spurs on the inner edge of the hind femora, with ten on the outer edge, this form has both sides spiny in their whole length.

Hab. North Island.

Genus Deinacrida, White.

I have now to describe another new species of Weta, which has been in my son's collection for some years. It was obtained by Mr. J. Brough in the Nelson Provincial District, and sent over preserved in spirits. Unfortunately the antennæ are wanting, but in every other respect the specimen is perfect. It seems to belong to the genus *Deinacrida*, and comes nearer to my *Deinacrida rugosa* than to *D. heteracantha;* but it is very small, even as compared with the former, and has other distinguishing features.

I exhibit this rare specimen alongside of the larger species. In addition to its diminutive size, it will be seen that the dorsal segments, or dermal plates if I may so term them, have a peculiar emarginate character, presenting the appearance of of a miniature coat of mail.

Deinacrida parva, sp. nov.

Male.—Body rounded above, somewhat compressed on the sides. Head slightly punctured on the vertex; thoracic shield more distinctly punctured; of the ten dorsal segments behind it, the two first have a slightly roughened surface, and the six abdominal ones are distinctly emarginate in the middle, with almost imperceptibly raised edges. Legs somewhat shorter in proportion than in *D. heteracantha*. Labial and maxillary palpi clavate at the tips. Cerci minute. Four anterior femora free from spines. Tibiæ quadrangular, both the inner edges armed with sharp spines. Hind femora similarly armed; hind tibiæ broader behind than on the sides, and furnished with sharp spines coming out alternately; their posterior edges also armed with minute spurs. General colour ochre-yellow; the thoracic shield dull reddish-brown, and the abdomen beneath darker. Length of the body, without appendages, 1·1; hind femora, 0·75; hind tibiæ, 0·75; tarsus and claws, 0·30.

Hab. South Island.

Art. XI.—*Observations on some peculiar Maori Remains, with Remarks on the Ancient Institution of* Tapu.

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 28th November, 1894.*]

I have the pleasure of exhibiting this evening for your inspection two somewhat remarkable specimens of Maori remains, respecting each of which I will offer one or two observations.

The first of these is a portion of a cranium of extraordinary thickness, exceeding even that of the Chatham Island Moriori, of which an example drawn from the collection in the Colonial Museum is now on the table. The specimen is too imperfect to admit of my giving many measurements. But, with a minimum frontal diameter of 100mm. and an external biorbital diameter of 113mm., it presents a maximum thickness of 10mm. The maximum thickness of the same bone in the Moriori is 8mm. With these specimens I exhibit a very typical Maori skull from the Island of Kapiti (presumably that of a Ngatitoa warrior), and also, for purposes of comparison, the skull of a Mallicolo Indian from the New Hebrides Group. The former has a lofty forehead and presents generally an intellectual character; whilst the latter is so depressed that it appears to have no forehead at all, this extraordinary shape of the head being due, it is said, to artificial pressure during infancy. Adopting the formula used by Professor Scott in his able paper "On the Osteology of the Maori and Moriori," which appeared in our last volume of "Transactions," it may be useful to give the comparative measurements of these two skulls, which are as follows:—

	Maori.	Mallicolo.
	mm.	mm.
Stephanic diameter of the cranium ..	116	85
Minimum frontal diameter	90	80
External biorbital diameter	110	109
Bijugal diameter	120	120
Bizygomatic diameter	130	128
Glabello-occipital length	155	175
Basi-bregmatic height	140	135
Basi-nasal length	111	120
Basi-alveolar length	118	130
Nasal height	71	71
Maximum transverse diameter ..	135	115

This very thick brain-case was obtained from that "necropolis" already described by me* as existing on the small wooded island in the Papaitonga Lake, and it may fairly be

* Trans. N.Z. Inst., vol. xxvi., p. 572.

assumed that its original owner was one of the ancestors of the Muaupoko people, now residing at Horowhenua.

The other specimen is part of a Maori skull, in which there is an abnormal growth of one of the teeth. It will be seen that the left upper canine or "eye-tooth" is turned completely upside down in its socket, the crown appearing in the region of the nostril, and the fang coming out in the roof of the mouth or palate. From the condition of the adjoining bicuspid, the enamel being worn away by long grinding and the dentine exposed, it evidently belonged to an adult, presumably a person past middle age. The reversed tooth is of the normal length, and its singular position is perhaps due to some injury to the upper jaw during youth, but not during infancy, because this is a fully-developed second tooth. The proper socket has become obliterated by absorption, and a thick covering of bone has been formed in front of the eccentric tooth, giving quite a normal appearance to the jaw.

This relic was obtained by my son in 1878 from a *wahi tapu* or sacred grove some six or seven miles up the Opotiki River, on the East Coast. The place of sepulture was a hollow tree about 4ft. in diameter. The bones of the dead had been deposited within the tree from an aperture about 12ft. from the ground, and the interments had been continued from time to time, till the hollow tree was completely filled up with human remains. For a long period of time this burial-place, protected by a thick clump of bush, had been unvisited by any Maori, the resident tribes having, with the advent of civilisation, adopted other modes of disposing of their dead. But the hollow tree-trunk, containing the remains of a former generation, had decayed with time and broken asunder, discharging its ghastly memorials in a confused heap all around. At the time of my son's visit, in company with Captain Mair, the place was so strictly *tapu* that it was considered unsafe for any European to trespass upon it, to say nothing of interfering with the human relics. My son had therefore to content himself with only a hurried inspection, and, in order to bring away the remarkable specimen now exhibited, had to break off and leave behind the major part of the skull. I believe the clump of bush is still under strict *tapu*, and it will probably remain so for many years to come. The island in the Papaitonga Lake, on the other hand, where he obtained the heavy cranium now exhibited, although the scene of a terrible slaughter, and practically the cemetery of the Muaupoko tribe, has never been *tapu* at all. This will no doubt seem strange to you, but it is readily explainable. The two cases afford a good illustration of the manner in which the Maoris of old understood and interpreted what Mr. Colenso has fittingly termed "that mysterious and intricate institution of the *tapu*."

The *tapu*, with its many rites, forms, and observances, was, so to speak, the foundation of Maori society, and the bulwark of tribal existence. The *tapu* "commenced with the birth of the New-Zealander, continued with him throughout life in all its varied scenes, and did not leave him until long after he was in the grave. The *tapu* regulated, or pretended to regulate, all his movements. It certainly enabled the Maoris to accomplish many heavy and useful works which without it they could not have done. Through it their large cultivations, their fisheries, their fine villages and hill forts, their fine canoes, their good houses, their large seine-nets, their bold carvings, and a hundred other things were accomplished—without possessing either iron or metal. Through it their fowl, and fish, and forests were preserved;" and through it the tombs and graves of their dead—objects held sacred even by the most untutored savage—were preserved inviolable. This far-reaching law of *tapu* had, as may readily be believed, a powerful influence over the Maori mind; so much so that, as Mr. Colenso adds, "the stoutest and fiercest of the chiefs bowed like an infant before it, and dared not disobey its behests." The tribal burial-place at Opotiki, primitive as it was, necessarily came under the protection of *tapu* in its strictest and most uncompromising form. On the other hand, the beaten Muaupoko, stripped of everything, and reduced in numbers to a mere remnant, who took refuge in the mountains, never dared to impose the spell of the *tapu* on the scene of their discomfiture and entombment. No better proof, perhaps, could be given of the complete conquest of the Muaupoko at that time by the Ngatitoa and Ngatiraukawa than the inability of the survivors ever afterwards to enforce the observance of this rite.* The nearest approach to it is what I have myself done in this present year of grace. I will explain. Among those who were killed in the great fight at Papaitonga was a celebrated chieftess named Te Riunga, an ancestress of the well-known chief Major Kemp Te Rangihiwinui. The island having come into my possession, I have erected upon it, in front of a grove of karaka-trees, the famous carved canoe "Te Koangaorehua," brought from Wanganui for that purpose. This monumental tomb, formed out of the end of a totara canoe of large dimensions, and elaborately carved to represent three human figures, one above the other, was erected some seventy years ago at Pipiriki (fifty miles up the Wanganui River) to mark the resting-place of Te Mahutu. After the battle of Moutoa, in 1863, when so many "friendlies" fell fighting on our side

* According to the doctrine of law which governs the Native Land Court, conquest, unless followed by actual occupation, confers no title to the land.

against the Hauhaus for the protection of Wanganui, it was decided to bring this monument down the river to Putiki, and erect it in the cemetery there in memory of those who had been killed, for the bones of Te Mahutu had long since been removed from Pipiriki to their final resting-place. This was accordingly done, and, whilst the loyal Natives were erecting their simple obelisk in the graveyard, Dr. Featherston, the Superintendent of Wellington, was uncovering a handsome marble monument in the Market Square at Wanganui, erected by the province to the memory of these brave defenders. But, owing to defective workmanship, in less than twenty years the carved monument toppled over, and, being still more or less *tapu*, was allowed to remain another ten years on the ground, having become in time completely hidden from view by a dense growth of vegetation. In order that it might be erected as a *tohu* for his ancestress, Te Riunga, Major Kemp presented to me this interesting monument, and it was accordingly conveyed by train to Papaitonga. It is still in an excellent state of preservation, and will, I trust, in its new location long remain to interest the visitor, whilst it marks the scene of one of the most cruel passages in Maori history.

Having said so much about the institution of *tapu*, I will ask your permission to quote here the evidence given by the well-known chief Hohepa Tamamutu, of Taupo, in the Native Land Court at Cambridge, at the hearing of the Whakamaru case, in 1883, because it is a very clear and authoritative statement:—

"The law of *tapu* is a universal custom among our race. There are many kinds of *tapu*, and it belonged to the owners of the land to decide the nature of the *tapu* they imposed upon any land. It was the right of the relations of the dead, being owners, to impose a *tapu;* and theirs only. An attempt by any others than the owners would be valueless.

"I will give instances: Wharengaro was one of the principal chiefs of Taupo. He died at Te Ariki, in the Arawa country, and was interred in the middle of a plantation where potatoes and kumaras had been grown. In fact, he was buried just where he fell—in his blood as he was shot. Te Hirapango was his companion, and shared his fate and his grave; but the tribe could not *whakatapu* the spot, because, while the dead chiefs were Ngatituwharetoa, the land belonged not to them but to the Tuhourangi. Had it been their own land they could have proclaimed it *tapu*. Long after, when the flesh was decayed, the bones were exhumed and removed to Tongariro; but the land was never *tapu*, and it is not so now.

"On the other hand, Te Heuheu (the elder) was buried by a landslip at Te Rapa, between Tokanu and Waihi. The

village was on the edge of the lake, and was completely buried. In consequence of this, the entire lake and the land within defined limits was *tapu*, lest the fish of the one and the productions of the other should be eaten by any one. This was proclaimed by Te Heuheu Iwikau. Nothing from the lake—fish, koura, &c.—could have been eaten on pain of death. It was not till five years after that the present Te Heuheu removed the *tapu*. He was the man whose right it was to do so, being the son of the deceased chief; and it was done to secure provisions for the gathering held for the lamentation over his father. No foreign chief could have done it. The ceremony was that the fish were caught, then removed to a place still *tapu*, and then cooked; then given to the priest, the *ariki*, and then eaten by him solemnly. No meaner person could have dared to do so. The high priest, the *ariki*, on this occasion, was Te Takinga, and it was his office to eat these first-fruits of the land.

"I take the instance of Te Rangituamatotoro. After his death he was conveyed by Tamaira to Motu-taiko. An earthquake shattered the island, and the bones fell into the lake. The water of the lake within certain limits was whakatapued. Now, there was a certain shallow (*tahuna*) in the lake that was a favourite fishing-ground, but it has been *tapu* ever since, and it is so still, and no one will dare to fish there.

"In all my experience I have never met with a single instance of a *tapu* laid by a foreign tribe upon land not their own property. Were such a thing attempted it would not be respected.

"I knew Totoia; also his elder brother, Te Ihukino. I heard of the *tapu* imposed because of his death. I was present at Waikari when Te Kaperakau and the others were there. Te Kaperakau—grandfather of Aperahama Te Kume [the claimant]—and the rest started to look for his body, but it could not be found. Totoia was a man of great consequence, as is proved by the land being made *tapu* for his sake. It was Te Kaperakau and Te Reweti who proclaimed the *tapu*."

A witness, however, on the other side gave the following evidence: "When I and my party visited Maungaiti we found Totoia living there alone. He was growing potatoes: that was all I saw. We slept there one night, and went on the next morning. Totoia gave us supper and lodging. There were several houses, but much dilapidated, and he himself had grown very old. He said that was his settlement. He was dressed in a cat-skin rug, painted inside with red ochre. The skins were of different colours. He wore it by day and he slept in it by night. We went on from Maungaiti to Tapapa and took up our residence there. After this we heard of Totoia's death at Maungaiti. I do not know how he died. We

did not go to fetch his body or look for it. The Ngatikikopiri did go, but I heard that it was supposed the pigs had devoured him, for he could not be found. . . I heard that Wahineiti died at Tauranga a natural death. His body was brought back to Patetere by the Ngatikea and the Arawa, and was deposited at Omaruapu in a small wooden hut in which he was seated. Then all Ngatiraukawa were summoned by messengers to come and see him. They assembled, and when they saw him they chanted a funeral dirge, to which Ngatikea and the Arawa responded; and then the Ngatiraukawa removed the body to Maungaiti, resting at Tokoroa on the way. On the birth of the child of Rangitaiki (the chief of Ngatikikopiri) it was called 'Nga-wi-o-Tokoroa,' and Hape's child was named Horohau, from the grass on which the corpse had lain and the wind that blew over it as it rested there. The body was then interred by the Ngatiraukawa at Maungaiti, because that was his own special territory. His remains were subsequently removed to Waotu when those of Hape were removed from Mangatautari, for the chiefs of the Ngatikikopiri decided that the two brothers should rest together."*

Referring to this, Hitiri Paerata (the hero of Orakau), who also gave evidence in the case, said, "Wahineiti was travelling through and died, and was taken to his own place. It was only the great people who were taken to the tribal sepulchres. The common people were buried where they died —anywhere."

I offer no apology for giving you these long extracts, because this evidence has never been published, and appears to me of considerable interest. I am of opinion that there would be no surer way of compiling a true history of the Maori people than by sifting and comparing the evidence recorded by the Judges of the Native Land Courts all over the country during the last thirty years. Of course much of it is unreliable and worthless; but that there are treasures of unspeakable value to the future Maori historian scattered through these countless volumes cannot for a moment be doubted. The real information is to be found in the private note-books of the Judges rather than in the minute-books of the Court, which for the most part are mere records of proceedings, or, at best, contain a mere outline of the evidence. For a period of sixteen years an accomplished Maori scholar occupied the position of Chief Judge of the Native Land Court, and I believe it was always his desire that a systematic effort should be made

* Wahineiti, the elder brother of Hape, died at Tauranga. He said to Ngatikea, "Don't take me to Maungatautari, but to Tokoroa, that the rushes of my land may grow over me; that I may drink the dews of Tokoroa." This occasioned the name of "Horohau." Therefore "Nga-wi-o-Tokoroa" became a proverb. (Evidence of Aperahama Te Kume.)

to collate this information and place it on record in some permanent form. A volume of "Important Judgments" of the Court was published some years ago, but nothing more has been achieved, if we except the publications, from time to time, of individual Judges of the Court. It is not too late now, for it is well known that the most capable of these Judges have preserved all their note-books. In the hands of a skilful compiler, possessing the necessary qualifications, a most interesting and valuable volume would be the result. For example, what could be more spirited than the sketch of Maori history contained in Mr. Fenton's judgment in the celebrated Pukehamoamoa case at Hawke's Bay—one of the last delivered by him—or what more poetic than the evidence in that case of Noa Te Huke, who rested his whole title on the dying words of his female ancestor, "Take me not away from the land, but bury me within hearing of the Rangitahi waterfall"?

There is another consideration to be borne in mind, and it is this: that, in the case of evidence given on oath, the natural tendency to romance is necessarily somewhat if not entirely curbed, and that consequently by this means a truer narrative ought as a rule to be obtained than by any other mode of inquiry. What, for example, could be more realistic and apparently truthful than the following passage taken from the evidence of Matiaha Peko, in the Rangatira case (1882), about the killing of Totohu?—"I was born at Te Ngei, and am the son of Takiau, the same man who killed Totohu in company with Te Kapiti, at Te Karangi, on the Pourewa. They killed him for stealing the eels there. Then they cut him up and ate him—ate the whole of him, except the head, and that we put on a pole. We dried it, Maori fashion (*mokomokai*), and took it to Turakina. There was a kumara ground there, and we set up the head on it to scare the pukekos. Afterwards it was thrown into an eel-pond or lagoon at Waiwhero. I helped to eat him. I saw the head. It was a huge head, with crisp hair, like a negro's (*poriki*), and the face completely covered with tatooing. He was said to belong to Ngatihauiti."

It would not require much play of the imagination to suppose that the remarkably thick cranium which I have exhibited this evening belonged to just such a head as that so graphically described by Matiaha Peko—that of the unhappy eel-poacher, Totohu.

Art. XII.—*Note on the Vegetable Caterpillar* (Cordiceps robertsii).

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

Plate VIII.

In the discussion which followed the reading of Mr. Maskell's paper on the 14th November, I maintained, in opposition to that gentleman's definition—"animal at one end, vegetable at the other"—that the so-called Vegetable Caterpillar, as we now find it, is entirely vegetable substance. The author, as I understood him, contended that the body of the caterpillar had become permeated with vegetable tissue, but that the outer integument or skin was still dried animal matter. To put an end to any possible doubt on the subject, I forwarded to Sir James Hector a specimen of the Vegetable Caterpillar, and asked him to get it examined and tested by the Government Analyst, for the purpose of ascertaining its true constituents. The following result has been officially communicated to me :—

Mr. Skey.

The question at issue is, whether the skin of the caterpillar remains, or if it has been converted into fungus like the soft internal tissues. The presence or absence of chitine will determine the question. Save the specimen for reference.

James Hector. 22/11/94.

Vegetable Caterpillar.—For animal matter in the so-called skin.

The skin does not give any indication of the presence of chitine or other animal substance. It burns without intumescence, and does not evolve the odour of nitrogenous matter in combustion.

William Skey. 23/11/94.

In the course of my remarks at the meeting I stated that I had dug up in the woods hundreds of this singular product, and that in every instance that had come under my observation the caterpillar, in the living state, had descended into the ground tail-foremost, the stem of the fungus afterwards springing from a point between the back of the head and the first fold of the neck, and then ascending vertically to reach the light. Since that date I have been examining the specimens in my collection, and I have found one very curious example in which there is evidence of a different proceeding on the part of the caterpillar, with exactly similar growth of the fungus. In this instance the caterpillar had evidently buried itself head-foremost, and then turned its head slightly to the left, whereupon the fungus had commenced its stem-growth at the usual point and travelled upwards in a line

with the body, curving and twisting somewhat before emerging at the surface of the ground.

In most specimens the stem is more or less twisted and sometimes bifurcate before it reaches the surface, after which it assumes a perfectly erect character, the fructification being at the top, 3in. or 4in. of the terminal part being covered with closely-set spores, having externally a granulate appearance. The longest stems I have met with ordinarily measure 7in. or 8in. from the insertion to the extreme tip.

I trust I have made myself sufficiently clear, but the peculiarity I have been describing is better seen on the accompanying plate (reduced from a photograph), in which fig. 1 represents this abnormal form. Figs. 2 and 3 on the same plate exhibit the Vegetable Caterpillar as it is ordinarily met with (upper and lower aspect), the smaller of the two showing the branched process I have mentioned, about an inch from its head. Fig. 4 illustrates the curved manner in which the caterpillar sometimes disposes its body before undergoing its final transmutation into fungus. The body of the specimen represented by fig. 1 measures 75mm., and its stem, measured in a straight line, 150mm. Although the caterpillars are of about equal size, the stem of No. 1, owing to its eccentric manner of growth, is 2·5in. longer than that of No. 2. (The body of the largest of the caterpillars here figured measures exactly 3in. in length.)

The popular notion that the Vegetable Caterpillar is found only under rata and kauri trees is quite an erroneous one. It is abundant in the southern parts of the North Island, where the kauri does not exist, and I have found it in localities from which the rata is entirely absent—for example, in small clumps of bush in the Taupo country. Indeed, it may be looked for in all suitable places, although, as a rule, it is more numerous near the summits of the wooded ranges, the fungus shooting up its little stem, like a miniature bulrush, among the dead leaves and decaying vegetation which cover the ground in such situations, often to the depth of several inches. After scraping away this surface covering it is necessary to dig out the Vegetable Caterpillar very carefully with a sheath-knife, the slightest attempt at forcing it up breaking the stem and destroying the specimen. Sometimes several are found grouped together within a foot of each other; but it requires a practised eye to distinguish the tiny stem among its surroundings of a similar hue. It is often rooted up and eaten by the wild pigs, and in the Taupo country I found the Woodhen digging up and devouring it. When fresh it has a pleasant nut-like flavour.

Art. XIII.—*On the Axial Skeleton in the Dinornithidæ.*

By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 3rd October, 1894.*]

Sir Richard Owen has described and figured different parts of the axial skeleton in the Dinornithidæ, and has distinguished what are now taken to be generic characters in the sterna of *Dinornis*, *Anomalopteryx*, *Meionornis* (= *Mesopteryx*) and *Pachyornis*.* Mr. R. Lydekker has distinguished the vertebræ and pelves of *Dinornis* and *Pachyornis*, and has also described the pelvis in *Megalapteryx* and *Anomalopteryx*;† and Dr. Parker has, quite recently, given a full description of the skull, so far as it is at present known, in all the genera.‡ I now offer, as a further contribution to our knowledge of these birds, descriptions of the vertebral column, pelvis, and sternum of *Euryapteryx* (= *Emeus* of Lydekker and Parker); the vertebral column and pelvis of *Meionornis* (= *Mesopteryx*); and some remarks on the vertebræ of *Megalapteryx*.

Nomenclature of the Genera.—The genus *Dinornis* is well established, and all the species admitted into it by Mr. Lydekker are also admitted by Dr. Parker and myself. The subgenus *Tylopteryx* appears to be unnecessary, for Parker has shown that the figures given by Owen, and by Jaeger in the palæontology of the voyage of the "Novara," are erroneous. I also abandon my attempt to resuscitate the genus *Palapteryx*, as the skull in the British Museum on which it was founded is said by Mr. Lydekker to be made up from the calvarium of *geranoides* and the præmaxillæ and mandibles of *casuarina*. A pelvis from Te Aute, belonging to Mr. A. Hamilton, is of the true *Dinornis* type, but much too small for *D. struthioides*, and I have little doubt but that it belongs to *Dinornis dromioides*. On the other hand, the pelvis in the Wellington Museum, which I associated with my *Palapteryx plena*, agrees fairly well with Mr. Lydekker's description of the pelvis in *Megalapteryx*. I also abandon the genus *Cela*. A part-skeleton of associated bones with the skull of *curtus* is in the Auckland Museum, and shows that it is congeneric with *didinus*, although differing somewhat in the sternum and vertebræ, as I shall presently point out. *Dinornis oweni* is

* Trans. Zool. Soc. of London, *passim*, and Ext. Birds of N.Z.
† "Catalogue of the Fossil Birds in the British Museum," 1891.
‡ Trans. Zool. Soc. of London, vol. xiii.

therefore quite distinct from it, and must be placed near *Anomalopteryx parva*.

We now come to the genus which includes *curtus*, *didinus*, *casuarinus*, and a larger species (*Mesopteryx b* of Parker), which is probably *rheides*. It is *Syornis* and *Cela* of Reichenbach; *Meionornis* of Haast; the typical *Anomalopteryx* of Lydekker (not of Reichenbach); and *Mesopteryx* of myself and Dr. Parker. Which of these should be adopted? Reichenbach's names, I think, cannot stand unless subsequently defined by some one else. His only knowledge on the subject was derived from Owen's published papers, and probably he never handled or even saw a moa bone. He gave no characters, but, without assigning any reasons for doing so, he placed in different genera each one of Owen's species, at a time when hardly anything was known about them. *Cela* (Möhring) is a synonym of *Casuarius*, and is not brought forward by Reichenbach as a new genus; the three species *curtus*, *casuarinus*, and *crassus* being grouped with *Casuarius*, while the species of *Dinornis* are grouped with *Dromaius*. If I had known this in 1891, when I was writing my paper on the moas of New Zealand, I should have ignored Reichenbach's names altogether. *Mesopteryx* also cannot be used here, as it has been previously given by H. de Saussure to a genus of Orthoptera.* To adopt *Anomalopteryx* for the generic name would now lead to confusion, as it was used by me—nearly simultaneously with Mr. Lydekker—for Reichenbach's typical species *didiformis*, and has been so used by Dr. Parker. Also *Meionornis* (Haast) has precedence of *Anomalopteryx* (Lydekker), and was fairly well defined. It was only Haast's mistake of identifying *didinus* as *didiformis* which led to Mr. Lydekker using the name of *Anomalopteryx* for this genus. I shall therefore take *Meionornis* as the correct name, and keep *Anomalopteryx* for the "Celine group" of Mr. Lydekker, as has been already done by Dr. Parker and myself.

For the next group—which includes *ponderosa*, *crassus*, and *gravis*—there is Reichenbach's old name of *Emeus*, which was only defined by Lydekker in 1891; and Haast's name of *Euryapteryx*, fairly well defined in 1874. Haast certainly mixed up *Euryapteryx* with his *Palapteryx (Pachyornis* of Lydekker), and I did the same. It was Mr. Lydekker who first clearly distinguished the two genera: still, I do not think that this is a sufficient reason for passing over Haast's name. *Emeus* was not given by Reichenbach as a new genus, but only as an amended spelling of *Emeu* (Barrère), which is identical with *Emou* (Vieillot), another synonym of *Casuarius*. By no canon of nomenclature can a genus *Emeus* of Reichen-

* "Mélanges Orthopterologuiques," fasc. iii., Mantidæ, p. 188 (1870).

bach be allowed. Of the correctness of the name *Pachyornis* there can be no doubt.

As the generic characters depend more on the axial than on the appendicular skeleton, it follows that the species in which the axial skeleton was first described must be taken as the type of the genus, and not the species to which the generic name was first applied, if the leg-bones only were known. This is necessary to prevent constant changes.

General Characters of the Vertebral Column.—So far as is at present known, all the moas have fifty-six vertebræ. Of these, 1 to 21 are cervical; 22 to 24 are cervico-thoracic; 25 to 27 are free thoracic, with sternal ribs articulating with the sternum. No. 28 is sometimes free, sometimes attached to the pelvic vertebræ; both it and No. 29 have floating sternal ribs. The pelvic (or syn-sacral) vertebræ are seventeen in number, from 28 to 44. No. 45 is sometimes anchylosed to those in front of it, sometimes free; Nos. 46 to 53 are free caudals; No. 54 is sometimes free, sometimes anchylosed to Nos. 55 and 56, which always form a single bone. The atlas is broadly oval, the longer diameter dorsi-ventral. The bony bridge for the vertebral artery is always strong. The post-zygapophyses are well marked; there is no trace of a neural spine. The pre-axial articulating surface is crescentic, the dorsal notch being very large.* It is much like the atlas in *Dromaius*, and very different from that of *Apteryx*.

The *axis* is comparatively short in an axial direction. The neural platform is triangular, with a nearly straight posterior margin. There is a deep pit behind the neural spine, and well-marked hyperapophyses. The posterior articulating surface is much elongated ventrad, and below it is a strong hypapophysis. This bone also closely resembles that of *Dromaius*, and is very different from that of *Apteryx*.

In the *cervical* vertebræ the centra increase in length to No. 16 or 17, and are proportionally longest and narrowest from 9 to 11. In Nos. 2 to 5 the hypapophysis forms a keel, which becomes obsolete on No. 6. A pair of hypapophyses spring from the ventral surface of the parapophyses in No. 6; they increase in size in each posterior vertebra, and are widest apart at No. 15 or 16. They then approach, and coalesce into a median tubercle on No. 19 or 20. Dorsad, the anterior cervicals, Nos. 3 to 6, expand into a quadrangular neural platform, which is transverse in Nos. 3 to 5, nearly square in No. 6. From this platform rises the neural spine, always divided into two on No. 6, and usually so on Nos. 3 to 5. On No. 7 the two neural spines are continued post-

* I have never seen an atlas resembling the one figured by Owen in his Ext. Birds of N.Z., p. 392.

axially as ridges on to the post-zygapophyses, and from No. 8 to 16 the spine cannot be distinguished from the ridge. But in No. 17 the spines again appear, increase in size on each posterior vertebra, and coalesce into a single spine on No. 21. In these vertebræ a distinct hyperapophysis can be recognized on the post-zygapophyses. This remarkable blending of the neural spines, hyperapophyses, and post-zygapophyses into two longitudinal ridges is very characteristic of the Dinornithidæ, and enables the cervical vertebræ to be distinguished from those of all other birds. Sir R. Owen and Professor Mivart call them the hyperapophyses, and Mr. Lydekker calls them the post-zygapophysial ridges. They will be distinguished in the present paper as the *neural ridges*. Between the pre-axial ends of the neural ridges there is a transverse bony bar, considered by Lydekker as the neural spine, on the post-axial side of which there is a deep fossa for the ligament. This transverse bar increases in height on the posterior vertebræ until it becomes blended with the neural spines in No. 21. The vertebrarterial canals are larger than the neural canal.

In the cervico-thoracic vertebræ the centra are approximately of the same size in all; but they can be distinguished by the hypapophysis which in No. 22 forms a compressed central nodule, extending in No. 23 to the pre-axial face, and in No. 24 covering the whole length of the centrum; usually projecting forwards in front of the pre-axial surface, and getting shallower towards the post-axial surface.

In the free thoracic vertebræ the centra have all the same length, but increase in breadth from No. 25 to No. 28. In No. 25 the hæmapophysis forms a deep keel from the pre-axial to the post-axial articulating surfaces, which is sometimes notched in the centre. In No. 26 the hæmapophysis is posterior, but there is also a slight anterior tubercle. In No. 27 the hæmapophysis is posterior only, sometimes single, sometimes divided. In No. 28 it forms two widely-separated posterior nodules. No. 27 can generally be further distinguished from No. 26 by the shape of the centrum, which is more compressed in the latter than in the former.

Of the pelvic vertebræ—Nos. 29 to 44—No. 30 always has the rib anchylosed to the centrum. Nos. 31 to 33 have transverse processes which unite with the pre-acetabular portion of the ilia. No. 34 sends stout transverse processes to meet the proximal ends of the ischia and pubes. In the next three—Nos. 35 to 37—transverse processes are absent, and this gives rise to a deep fossa on each side, in the centre of the pelvis (the pelvic fossæ). Nos. 38 to 44 have transverse processes which coalesce with the posterior portion of the ilia and form, dorsad, the sacrum, or pelvic disc of Sir R. Owen.

A very good series of woodcuts of vertebræ are given by Owen in Trans. Zool. Soc., vol. x., pp. 152–170, and in "Extinct Birds of New Zealand," pp. 396–414. These, which are referred to *Dinornis maximus*, really belong to *Pachyornis*, as has already been pointed out by Mr. Lydekker. A correction in the numbers of these vertebræ will be useful :—

Figs. 8–11 are	Vert. No. 4.	Figs. 18–21 are	Vert. No. 21.
Figs. 12, 13 are	„ „ 6.	Figs. 25, 26 are	„ „ 23.
Fig. 14 is	„ „ 8.	Figs. 27–29 are	„ „ 24.
Figs. 15, 16 are	„ „ 17.	Fig. 30 is	„ „ 25.
Fig. 17 is	„ „ 18.	Figs. 31, 32 are	„ „ 27.
Fig. 22–24 are	„ „ 20.	Figs. 33, 34 are	„ „ 28.

Rings of the Trachea.—Two types of ossified tracheal rings are found with moa-bones : (1) The hoop-like rings of Lydekker, which are slender, smooth, and often elliptical in shape; (2) the tube-like rings of Lydekker, which are thick, rough, deep, and circular in section. These two types have always been considered as generically distinct, but such is not the case. In a skeleton of *Euryapteryx ponderosa*, found by Mr. B. S. Booth in the central district of Otago, the trachea was nearly complete, and it had hoop-like rings near the head and tube-like rings near the sternum, one set gradually passing into the other about the middle of its length. This was probably the same in all the moas, as some of the tube-like rings are very small.

In the following remarks I shall treat all the free vertebræ which have ribs as *thoracic*—that is, from No. 22 to No. 28. Those in front of them are cervical ; those behind them belong to the pelvis.

Genus DINORNIS, Owen (1843).

Type—**D. robustus**, Owen.

Figures.—*Atlas*, Owen, Trans. Zool. Soc., vol. v., pl. 53, figs. 4–6, and Ext. Birds of N.Z., pl. 62. *Axis*, Owen, Trans. Zool. Soc., vol. x., p. 150, figs. 4–7, and Ext. Birds, p. 394. *Cervical vertebræ*, Owen, Trans. Zool. Soc., vol. iii., pl. 40, and Ext. Birds, pl. 32. Lydekker, Fossil Birds, Brit. Mus., p. 247, fig. 59. *Pelvis*, Mivart, Trans. Zool. Soc., vol. x., p. 43, figs. 42, 43. *Sternum*, Owen, Trans. Zool. Soc., vol. x., pl. 32, and Ext. Birds, pl. 98. Lydekker, *l.c.*, p. 222, fig. 56.

CERVICAL VERTEBRÆ.

In the *axis* the odontoid process is long, tapering, and slightly rounded. The pre-axial articulating surface moderate, the height less than the breadth. The neural spine is remarkably high and thick. The *anterior cervicals*—2 to 6—are short and broad. In No. 5 the length is three-quarters of the

breadth, and the height of the post-axial face of the centrum is equal to the breadth; the posterior margin of the neural platform is straight or slightly concave. The neural spine is not divided in Nos. 3, 4, or 5. Hyperapophyses are well developed on No. 4, slightly so on No. 5. The faces of the post-zygapophyses in Nos. 4 and 5 are directed more post-axially than in other genera. *Middle cervicals*, 7 to 17: The post-axial surface of the centrum is broad, the greatest breadth at the ventral margin being more than twice the least vertical (dorsi-ventrad) height; and the ventral breadth less than twice the dorsal breadth. There is generally a pneumatic foramen behind the diapophysis. The neural ridges are more elevated than in any other genus, and converge only slightly pre-axiad; the transverse bar is high, with well-marked pre- and post-axial rough ligamentous areas. The faces of the post-zygapophyses are directed more outwards than usual; and usually there is a deep conical pit on each side at the pre-axial end of the neural ridges. The *posterior cervicals*—18 to 21—have the same characters, but the centra shorten in length considerably, and there are no pits at the pre-axial bases of the neural spines. The neural spine is occasionally single on 19 and 20, and the hæmapophyses become single on 20.

Thoracic Vertebræ.

The centra have broad post-axial surfaces. The anterior pneumatic foramen is very large, and in Nos. 24 to 28 descends below the rib-facet (in very old birds this foramen becomes obliterated); the posterior pneumatic foramen is large in all. The hæmal ridge (hypapophysis) is not continued to the posterior end of the centrum in 22. In 23, 24, and 25 it extends all along the centrum, but is deeper pre-axiad, and often projects forwards as a hook. The transverse processes are short and thick, as also are the neural spines, which in Nos. 22 and 23 are nearly square in section, and have both pre- and post-axial surfaces remarkably rough. The post-zygapophyses are short, with broadly-oval faces; the channels between them and the buttresses of the neural spine are shallow. The pre-zygapophyses are short, and not expanded at the extremity.

Pelvis.

The pre-acetabular portion of the ilium is moderately deep, the anterior margin projecting much forwards, and the dorsal margin nearly straight axially. The anterior margin of the acetabulum is in the centre of the ilium. The posterior portions of the ilia begin to diverge at the anterior margins of the acetabula, but soon become more nearly parallel than in any other genus. The post-acetabular portion is short, and does

not project beyond the 45th or 46th vertebra; its lateral surface slopes downwards and outwards; and posteriorly it descends as a sharp ridge below the vertebral column. The ischia and pubes project backwards beyond the ilia. The ventral surfaces of the sacral vertebræ—35 to 37—are short, broad, and flat. The transverse processes of Nos. 38 and 39 are at right angles to the axis, but in all the posterior vertebræ these processes slope obliquely backwards, thus leaving a triangular fossa on each side behind the usual pelvic fossæ.

Sternum.

The body is broad, with well-marked coracoid pits, short costal processes, long and diverging curved lateral processes, and the median process often notched.

Genus MEGALAPTERYX, Haast (1885).

Type—**M. tenuipes**, Lydekker.

Figures.—Pelvis, Lydekker, Fossil Birds in Brit. Mus., p. 278, fig. 63, and fig. 61 (outline).

The twelve more or less imperfect vertebræ here described were found in a cave in the Lower Buller district with a cranium and leg-bones of *M. tenuipes*. The cranium has been described by Dr. Parker in Trans. Zool. Soc.

Cervical Vertebræ.

In the *middle cervical* region the centra are long and narrow; the post-axial surfaces broad. The hypapophyses arise considerably behind the pre-axial surface. The neural ridges are very low and flat, converging rapidly anteriorly; the transverse bar low, and rising very obliquely. A saucer-shaped depression on each side at the pre-axial base of the neural ridge. Faces of the post-zygapophyses more horizontal than in *Dinornis*. The *posterior cervicals*—19, 20, 21—have the centra short. The hypapophysis is single on No. 19; on No. 20 it forms a short, compressed anterior ridge, which in No. 21 extends backwards over the greater part of the centrum. The neural spine is double in No. 19; single in 20 and 21. Hyperapophyses occur on Nos. 20 and 21, but not on 19.

Thoracic Vertebræ.

Nos. 22, 26, and 27: The post-axial faces are broad. The anterior pneumatic foramen descends below the rib-facet in Nos. 27 and 26, and in 22 it is slightly developed. The posterior pneumatic foramen is large in 27 and 26, obsolete in 22. The hypapophysis in No. 22 forms a central compressed

keel. The transverse processes are moderate and distinctly ascending. The neural spine in No. 22 slopes forward, and is much compressed; in Nos. 26 and 27 it is short, compressed, straight or slightly curved forwards. The post-zygapophyses form a right angle with each other; their faces are broadly oval. The pre-zygapophyses are moderate.

Pelvis.

The pelvis is narrow, and the anterior margin of the acetabulum is in the centre of the ilium. The pre-acetabular portion of the ilium is deep, and the two meet dorsally in an arched ridge. They begin to diverge far back, behind the acetabula; their lower post-acetabular margins are thick and blunt. The ventral surfaces of the post-sacral vertebræ are slightly longitudinally ridged.

Genus MEIONORNIS, Haast (1874).

Anomalopteryx (typical), Lydekker (1891). *Syornis* and *Mesopteryx*, Hutton (1891).

Type—**M. casuarinus**, Owen.

Figures.—Sternum, Owen, Trans. Zool. Soc., vol. vii., pl. 8 and 9; Ext. Birds of N.Z., pl. 73 and 74. Lydekker, Fossil Birds in Brit. Mus., p. 254, fig. 62A.

Cervical Vertebræ.

The *axis* has the pre-axial articulating surface narrow, the height being nearly as great as the breadth. The hypapophysis descends pre-axially more abruptly than in other genera. The odontoid process is very short. The neural spine high and much compressed. The hyperapophyses also compressed.

The *anterior cervicals*—3 to 6—are distinguished by the neural spine being single on No. 3, and only partly divided on No. 4. The hyperapophyses are small on Nos. 4 and 5. The post-axial margin of the neural platform is straight in 3 and 4; concave in 5 and 6. In No. 6 also the platform is slightly arched dorsad. The *middle cervicals*—7 to 18—have long narrow centra, with the post-axial surface broad ventrad and narrow dorsad; the breadth of the ventral margin is more than the height, and more than one and a half times that of the dorsal margin. Usually there is a pneumatic foramen behind the diapophysis on Nos. 15 to 18. The hypapophyses rise immediately behind the pre-axial margin of the centrum. The neural ridges are high and converge rapidly, their post-axial ends being twice as far apart as their pre-axial ends. The transverse bar is high and rises abruptly. At the pre-

axial base of each neural ridge there is a saucer-shaped depression which is sometimes pierced by a foramen under the zygapophysial bridge. The faces of the post-zygapophyses are more horizontal than in *Dinornis*. Hyperapophyses are distinct on No. 18. The *posterior cervicals*—19 to 21—have short, but comparatively narrow, centra on all. The neural spine is usually single on No. 21 only. The hypapophysis is single on No. 19. The hyperapophyses are distinct in Nos. 19 and 20. Posterior pneumatic foramina are developed in all.

THORACIC VERTEBRÆ.

Post-axial faces broad. In Nos. 22 and 23 the dorsal margin is rather less than the height, while the ventral margin is more than the height; in all the others the sides are parallel; the breadth is about equal to the height in 24 and 25, and greater than the height in the others. The anterior pneumatic foramen descends below the rib-facet in 27 and 28, but is often divided into dorsal and ventral portions by a bony septum. In 26 it is large, and often reaches slightly below the rib-facet, but is not divided; in 24 and 23 it is often small or obsolete, but usually developed again on No. 22. The posterior pneumatic foramen is generally well developed on all. The hypapophysis in 22 and 23 is central; in 24 and 25 it is continuous the whole length of the centrum, and is slightly notched in the middle in No. 25. There is a small anterior tubercle in Nos. 26 to 28. The transverse processes are long, especially in Nos. 25 and 26, and rise slightly. The neural spine is much inclined forward in No. 22; in the others it is long and compressed; straight or slightly curved forwards in 26 to 28. In these three the neural spine is twice as long as the distance from its base to the ventral margin of the centrum. The post-zygapophyses rise rapidly, and their faces are narrowly oval; they form a right angle with each other, but the valley between them is shallow. The pre-zygapophyses are moderate, slightly expanding distally.

PELVIS.

Pre-acetabular portion of the ilia moderately deep, forming a sharp dorsal ridge, which is curved axially. The centre of the acetabulum is in the centre of the ilium. The ilia begin to diverge at the anterior margins of the acetabula, and are prolonged backwards rather beyond the centrum of No. 46, making a broad pelvic disc: the angle of divergence is between 60° and 70°. The lateral surface of the post-acetabular portion of the ilium slopes downwards and inwards, and posteriorly projects as a sharp ridge below the vertebral column. The ventral surfaces of the sacral vertebræ are

broad, but longitudinally ridged; the transverse processes of the posterior ones are strong, slightly oblique, and leave no second fossa.

STERNUM.

Body nearly quadrate, anterior margin slightly curved dorsally; costal processes long and directed much dorsad, but not pre-axiad; lateral processes long, slender, not diverging much; median process long. No coracoidal depressions, but internally there are deep pneumatic depressions at the antero-lateral corners.

NOTE.—*M. curtus* differs from the others in the following points: The cervical vertebræ have flatter neural ridges, and often no depression at their pre-axial bases. In the thoracic vertebræ the anterior pneumatic foramen does not descend so low, and is not divided by a septum, and there is no posterior pneumatic foramen in No. 28. The neural spine is shorter, and the faces of the zygapophyses are broader. The sternum has no pneumatic depressions in the antero-lateral corners.

Genus ANOMALOPTERYX, Hutton (1891).*

Anomalopteryx (Group *Cela*), Lydekker (1891).

Type—**A. parva**, Owen.

Figures.—Owen, Trans. Zool. Soc., vol. xi., pl. 51 to 58. Haast, Trans. Zool. Soc., vol. xii., pl. 31 and 32.

The material in the Museum is not sufficient to enable me to give a full description of the vertebral column; but the following is offered as a contribution. The vertebræ resemble those of *Pachyornis* more than any other genus.

CERVICAL VERTEBRÆ.

Anterior cervicals, 4 and 5: The neural spine is divided nearly to the base in both. The post-axial margin of the neural platform is deeply concave in both. Hyperapophyses are strong on No. 4, but not strong on No. 5.

Middle cervicals have the centra moderately long; the hypapophyses rise close to the pre-axial border. The neural ridges are flattened, but carry narrow hyperapophyses. The transverse bar is low, and rises very obliquely. There is no depression at the pre-axial base of the neural ridge. The *posterior cervicals* have the hypapophysis single on both 20 and 21; while the neural spine is double in No. 20, and either single or double in No. 21.

* "New Zealand Journal of Science," Nov., 1891, p. 248.

THORACIC VERTEBRÆ.

The post-axial surfaces of the centra are narrow. The anterior pneumatic foramen does not descend below the rib-facet. The posterior pneumatic foramen is well developed. The post-zygapophyses form an acute angle with each other, and the pre-zygapophyses are short.

PELVIS.

Narrow. Centre of ilium half-way between centre and anterior margin of acetabulum. Pre-axial portion of ilia rather low, and sharply ridged; dorsal margin nearly straight axially. The ilia begin to diverge behind the anterior margin of the acetabula, and extend backwards to vertebra No. 46. Ischia generally extending slightly beyond the ilia. Lateral surfaces of post-acetabular portion of ilia the same as in *Meionornis*. Ventral surfaces of sacral vertebræ long, not ridged. Transverse processes of posterior vertebræ more oblique and stronger than in *Meionornis*.

STERNUM.

Body quadrate; the anterior margin strongly curved dorsad, the costal processes long and directed dorsad also. Coracoid depressions deep and oval. Shallow pneumatic depressions on the inside at the antero-lateral corners. Lateral processes stronger than in *Meionornis*. Scapulo-coracoid about 3¼in. in length, of which the coracoid occupies one-third; not much expanded at the anchylosis.

Genus PACHYORNIS, Lydekker.

Euryapteryx, in part, Hutton.

Section A. Type—**P. immanis**, Lydekker.

The following description is taken from a nearly-complete vertebral column found with the skull, sternum, pelvis (fragmentary), and most of the leg-bones, the latter being typically *immanis*.

CERVICAL VERTEBRÆ.

Anterior cervicals—3 to 6—have the post-axial surfaces of the centra more quadrate than in any other genus, the height being equal to the breadth in No. 4, slightly greater than the breadth in No. 3, and less than the breadth in No. 5. Greatest breadth of No. 3 is 38mm. (1·5in.). The neural spine is divided nearly to the base on Nos. 3, 4, and 5. The zygapo-

physial faces look more dorsi-ventrad than in *Dinornis*, and they are not so broad. In the *middle cervicals*—11 to 14—the centra are very short, and the post-axial surface very broad; the width at the ventral margin more than one and a half times that of the dorsal margin, the height less than one-half the ventral breadth. No pneumatic foramen on Nos. 7 to 10. Hypapophyses rise immediately behind the pre-axial border of the centrum in Nos. 13 and 14, and nearly so in the anterior vertebræ. Neural ridges very short, and nearly parallel, steep-sided in the anterior vertebræ, but getting quite flat in the posterior ones; the transverse bar well developed in all. An inter-zygapophysial bridge in 11 and 12. A shallow saucer-shaped hollow at the pre-axial base of the neural ridge. Faces of the post-zygapophyses nearly horizontal (as in *Meionornis*). *Posterior cervicals*, 15 to 21: Centra short; pneumatic foramina in all. A deep valley in front of the hypapophyses in No. 17. Neural ridges high, but short, in No. 15; a pit on their inner sides in Nos. 16 to 18. Hyperapophyses distinct in No. 18.

Thoracic Vertebræ.

Post-axial faces of the centra moderate, narrowest in No. 25. In No. 22 the ventral breadth is considerably more than the height; in No. 24, also, the ventral margin is greater than the dorsal; but in the others the sides are parallel, and the height is about equal to the breadth. The anterior pneumatic foramen is situated entirely above the rib-facet; it is well developed in Nos. 28–25, small in Nos. 24 and 23, and absent in No. 22. The posterior pneumatic foramen is small or absent in Nos. 28–23, but well developed in No. 22. The hypapophysis in No. 22 is a compressed central nodule; in No. 23 it extends over the anterior half only of the centrum; in 24 it is continuous along the whole of the centrum; in 25 it is divided in the centre into two parts: there is an anterior nodule on 26, but not on 27. The transverse processes are rather short; the neural spine in No. 22 is much inclined forwards (in all the others they are broken off). The post-zygapophyses are inclined to each other at about a right angle; the valley between them is shallow. The pre-zygapophyses are shorter than in any other genus, and they are but slightly expanded distally.

Sternum.

Resembles that figured by Sir R. Owen in Trans. Zool. Soc., vol. vii., pl. 7, and Ext. Birds of N.Z., p. 72. The body is broad and flat, with strong lateral processes, which diverge much from the central line. Median process short. Anterior border slightly curved; the costal processes well developed.

No coracoid depressions; but distinct pneumatic depressions inside.

The pelvis is too fragmentary for description.

Section B. Type—**P. elephantopus**, Owen.

CERVICAL VERTEBRÆ.

The *cervical vertebræ* differ from the last in the post-axial surfaces of the centra being narrower, and the neural ridges considerably longer, and the bar between them rising very obliquely. The *thoracic vertebræ*, from No. 28 to No. 24, have well-developed posterior pneumatic foramina. The transverse processes are longer; as also are the pre-zygapophyses, with a deep channel between them.

This type is much more common than the first, and is represented in Sir R. Owen's drawings, Trans. Zool. Soc., vol. x., pp. 152–170, and Ext. Birds of N.Z., pp. 396–414.

PELVIS.

The pelvis is very broad, and the centre of the acetabulum is in the centre of the ilium. The pre-acetabular portion of the ilium is low, and the two meet dorsally in a rounded ridge, which is straight in an axial direction. They do not project in front of the neural spine of No. 28 vertebra. They begin to diverge before the anterior margins of the acetabula, and then form a broad pelvic disc, the angle of divergence being about 70°. The posterior portion of the ilium is very broad and flat, and does not project beyond vertebra 45 or 46. The lateral surface is perpendicular and very shallow, not projecting as a ridge below the vertebral column. The ventral surfaces of the sacral vertebræ are narrowed; the transverse processes of the posterior vertebræ are strong and not very oblique, those of Nos. 38 and 44 being at right angles to the axis.

STERNUM.

Same as in Section A.

Genus EURYAPTERYX, Haast (1874).

Emeus, Lydekker (1891).

Type—**E. gravis**, Owen.

CERVICAL VERTEBRÆ.

The *atlas* has the neural canal transversely oval, the horizontal diameter rather more than one and a half times the vertical. The pre-axial articulating surface is crescentic, the margins, if continued, forming a circle. Post-zygapophyses distinct, projecting post-axially, and carrying distinct rounded

hyperapophyses; the articular face looks inwards and slightly ventrad. In the *axis* the pre-axial articulating surface is crescentic, the height not quite half the breadth, and nearly straight dorsad, at the root of the odontoid process. The post-axial surface is higher than broad, with straight sides, and both dorsal and ventral margins concave. The odontoid process is moderate, tapering, bluntly rounded, the upper surface concave; a slight cup on each side, near the base, for articulation with slight tubercles at the post-axial bases of the neural laminæ of the atlas. The hypapophysis is strongly developed post-axially, but fades away about the middle of the centrum, the anterior portion of which is smooth. Neural platform triangular, its post-axial margin slightly concave, and its breadth considerably greater than the length to the tip of the odontoid. Neural spine short and stout. The post-zygapophyses look almost completely ventrad, but slightly post-axiad; the hyperapophyses prominent and rounded, not compressed. *Anterior cervicals*, 3 to 6: The post-axial margin of neural platform straight in No. 4, concave in Nos. 5 and 6. Neural spine divided to the base in all. Hyperapophyses strong on Nos. 3 and 4 only. *Middle cervicals*, 7 to 14: Centra moderate or rather short; the post-axial face narrowed dorsad: breadth at ventral margin less than one and a half times that of the dorsal margin; the height slightly greater than the dorsal breadth. Generally a pneumatic foramen below the diapophysis in Nos. 10 to 14; sometimes another behind it in Nos. 12 to 14. The hypapophyses from Nos. 9 to 14 rise some distance behind the pre-axial border of the centrum. The neural ridges rise abruptly, and from Nos. 6 to 12 they converge rapidly, the distance apart of the post-axial ends being considerably more than twice that of the pre-axial; but in Nos. 13 and 14 they are more nearly parallel. The transverse bar is very low, and rises obliquely. There is a deep conical pit on each side at the pre-axial ends of the neural ridges, usually with a foramen at the bottom; there is also usually a foramen in the inner faces of the neural ridges, near their anterior ends. The faces of the post-zygapophyses look more outwards than in *Meionornis*. *Posterior cervicals*, 15 to 21: The centra are short; the post-axial face in No. 19 has the height in the centre about equal to the dorsal breadth. There is a pneumatic foramen behind the diapophysis in all, and usually one below it also. The hypapophyses are separated from the anterior border of the centrum by a transverse groove. They are single on Nos. 19 to 21, usually forked on No. 18, and double on No. 17. The neural spine is single on No. 20; double, or forked, on No. 19. Hyperapophyses are well marked on 18 to 21.

THORACIC VERTEBRÆ.

The post-axial surfaces of the centra are narrow: in No. 22 the height is rather more than the greatest breadth, and they get narrower to No. 26, in which the height is one and a half times the breadth; in No. 28 the height is about equal to the breadth in the middle. The anterior pneumatic foramen descends below the rib-facet in No. 28, slightly so in Nos. 27 and 26, and becomes obsolete in No. 24. There is a posterior pneumatic foramen in all. The hypapophysis in No. 22 forms a compressed central nodule, deepest behind. In No. 23 it is longer, but does not reach either end of the centrum. In No. 24 it is continuous as a keel and projects forwards. In No. 25 there is no notch, but a slight posterior nodule, and the keel does not project forward. There is an anterior nodule in No. 26, but not in 27. The transverse processes are rather long and thick; not ascending. The neural spines are long, that of No. 22 sloping forward but slightly, those of the posterior vertebræ often much curved forwards. The post-zygapophyses make an acute angle with each other, the valley between them deeply hollowed out, and in No. 25 they are deeply channelled on the upper surface. Pre-zygapophyses long and expanded distally.

PELVIS.

The pelvis is broad, with the centre of the acetabulum in the centre of the ilium. The pre-acetabular portions of the ilia are deep, and produced forwards in front of the neural spine of No. 28 vertebra. Dorsad they meet in a sharp ridge, which is often curved in an axial direction. The ilia begin to diverge at the anterior margins of the acetabula, and form a broad pelvic disc, the angle of divergence being about 90°. The post-acetabular portions of the ilia are produced backwards beyond No. 46 vertebra; their lateral surfaces are perpendicular and short, forming ventrad a sharp ridge which does not descend so much as in *Meionornis*, but more so than in *Pachyornis*. Ventral surfaces of the sacral vertebræ as in *Meionornis*. The transverse processes of the posterior vertebræ, 40 to 44, very oblique. The ischia project considerably beyond the ilia.

STERNUM.

The body is quadrate, or broader than long; with strong, straight lateral processes, which do not diverge much. Median process long. Anterior border slightly curved; the costal processes large, slightly directed dorsad. No coracoid nor pneumatic depressions.

In the absence of illustrations the following keys may assist in distinguishing between the genera:—

MIDDLE CERVICAL VERTEBRÆ.

Neural ridges nearly parallel.
- Neural ridges high .. .. .. Dinornis.
- Neural ridges low.
  - Transverse bar high; ridges short .. Pachyornis, section A.
  - Transverse bar low; ridges long .. Pachyornis, section B.

Neural ridges markedly converging.
- Neural depressions* deep .. .. Euryapteryx.
- Neural depressions shallow.
  - Dorsal margin of post-axial surface of centra less than two-thirds of the ventral margin .. .. .. Meionornis.
  - Dorsal margin of post-axial surface of centra more than two-thirds of the ventral margin.
    - Centra elongated .. .. Megalapteryx.
    - Centra shorter .. .. .. Anomalopteryx.

THORACIC VERTEBRÆ.

Anterior pneumatic foramen descending below the rib-facet in No. 27.
- Posterior faces of the centra of Nos. 26 to 24 broad.
  - Neural spines short, square .. .. Dinornis.
  - Neural spines short, compressed .. Megalapteryx.
  - Neural spines long, compressed .. Meionornis.
- Posterior faces of the centra of Nos. 26 to 24 narrow .. .. Euryapteryx.

Anterior pneumatic foramen not descending below rib-facet in No. 27.
- Post-zygapophyses form an acute angle with each other .. .. .. Anomalopteryx.
- Post-zygapophyses form a right angle with each other.
  - No posterior pneumatic foramen .. Pachyornis, section A.
  - A posterior pneumatic foramen .. Pachyornis, section B.

PELVIS.

Centra of ribless post-sacral vertebræ (Nos. 35 to 37) forming a mass which is as broad as long, and transversely ridged. Two pelvic fossæ on each side.. .. .. Dinornis.

Mass of ribless centra longitudinally keeled or ridged: generally longer than broad.
- Ilia diverge at an angle of about 65° .. Meionornis.
- Ilia diverge at an angle of about 90° .. Euryapteryx.

Mass of ribless centra much longer than broad, nearly smooth, or slightly ridged.
- Lower surface of the centra rounded .. Pachyornis.
- Lower surface of the centra flat, with sharp lateral margins.
  - Posterior portion of ilium sharply ridged below .. .. Anomalopteryx.
  - Posterior portion of ilium flat below .. Megalapteryx.

* The depressions at the pre-axial ends of the neural ridges.

STERNUM.

Coracoid depressions deep.	
Body of sternum broader than long; lateral processes widely diverging	Dinornis.
Body of sternum quadrate; lateral processes not widely diverging	Anomalopteryx.
No coracoid depressions.	
Body of sternum broad; lateral processes widely diverging	Pachyornis.
Body of sternum quadrate; lateral processes not widely diverging.	
Pneumatic depressions deep	Meionornis.
Pneumatic depressions none	Euryapteryx.

ART. XIV.—*On the Occurrence of a Pneumatic Foramen in the Femur of a Moa.*

By Captain F. W. HUTTON, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd May, 1894.*]

Plate IX.

IN his second paper on *Dinornis* Sir R. Owen remarks, on some moa remains from Poverty Bay, that "in only one out of eighteen femora are the parietes of the bone deficient at the part where the air is admitted into the interior of the shaft in the ostrich, emu, rhea, and cassowary; but in the exceptional instance cited the cavity does not lead to the interior of the bone, and may be due to accidental fracture, as there is a similar opening on the opposite side. In all the other femora of the *Dinornis* the parietes at the back part of the proximal extremity of the bone are entire, as in the *Apteryx;* and both the weight and cancellous structure of these bones prove the accuracy of the statement made in the original description of the original fragment that the *Dinornis* retains the medullary contents of the cavities of the femur throughout life, as in the *Apteryx*."*

In the large number of femora of moas of all ages which have passed through my hand I have never, before now, noticed an opening for an air-sac—although there are usually two nutrient foramina in the place where the air-canal exists in the emu—and this absence of a pneumatic foramen in the femur is taken as one of the most essential characters of the

* Trans. Zool. Soc., iii., p. 248; and "Extinct Birds of New Zealand," p. 86.

Dinornithidæ; so much so that both *Dromornis australis* and *Dinornis* (?) *queenslandiæ* were placed by their original describers among the moas largely because in them also the femur is non-pneumatic. Nevertheless this character is not absolutely constant even in the true Dinornithidæ of New Zealand. I now exhibit to the members a femur of an adult bird belonging to *Pachyornis pygmæus*, from the Te Aute Swamp, near Napier, in which the pneumatic foramen is well developed (Plate IX., *p.f.*). The opening is subtriangular in shape, and about half an inch in diameter. It is placed at the posterior base of the neck, slightly more interior than the same cavity in the emu. The interior-lower margin is broken, and evidently extended further, but the external and upper margins are quite smooth and rounded, and are unquestionably in their natural condition, so that the interior-lower margin could not have extended much farther. The canal leading from the opening is divided by a longitudinal septum into two parts, each of which contracts into a narrow tube, through which a fine wire can be pushed into the interior of the bone. Probably no air-sac penetrated into the canal, but blood-vessels alone passed through the two tubes. Nevertheless the large opening is evidently a reversionary character, and a proof that a pneumatic canal and air-sac existed in the ancestors of the moas.

EXPLANATION OF PLATE IX.

Posterior aspect of left femur of *Pachyornis pygmæus*, reduced to $\frac{5}{9}$ natural size: *p.f.*, pneumatic foramen.

Art. XV.—*On a New Species of Weta* (Locustidæ) *from Bounty Island.*

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd May, 1894.*]

During the last trip of the C.S.S. "Hinemoa" to Bounty Island Captain Fairchild collected, under some rocks, specimens of one of those wingless locusts called weta by the Maoris—by which name they are known to all New-Zealanders. As there are no trees nor shrubs on the island—nothing but bare rocks—it seems that these insects must feed on the dead seaweed. It is an interesting problem how so large an insect got to a small island about two miles long, composed only of

volcanic rocks not more than 100ft. high, and some four hundred miles south-east from Banks Peninsula.

The specimen presented to the Museum is a male, and between 1¼in. and 1½in. in length. It is very distinct from any wetas I have seen from New Zealand, and probably, therefore, the species has existed for a long time on those barren rocks, over which the sea-spray constantly flies. I place it temporarily in *Ceuthophilus*, but it differs from that genus in the shape of the eyes, in the maxillary palpi, and in having a low tubercle on the sternum. However, until the New Zealand wetas are better known, it will, perhaps, be as well not to make a new genus for its reception; and my only reason for giving a description of it is the interest attached to its habitat. The description of the female is from a specimen in the Otago University Museum.

Ceuthophilus (?) **isolatus**, sp. nov.

MALE.—*Head* moderate, not broader than the prothorax; smooth, faintly transversely striated on the epicranium just above the clypeus. *Antennæ* short, about one and a half times the length of the body, slender, closely approximated at the base but not touching; the first joint rather flattened, slightly longer than broad, and gently curved with the convexity inwards; second joint shorter than the first, nearly as broad as long, slightly inflated in the middle; third joint longer than the first, twice as long as the second, slightly inflated towards the base; fourth and following joints much shorter, about equal, as long as broad, getting smaller towards the distal end, where they are irregular, and many are longer than broad. *Eyes* sub-semicircular, touching the rim of the cavity for the articulation of the antennæ. *Ocelli* none. *Frontal keel* reduced to a prominent double spine, the base of which does not extend between the bases of the antennæ. *Labrum* moderate. *Mandibles* small. *Maxillary palpi* moderate in length; the relative length of the joints is 5, 3, 4, 2, 1—the fifth about as long as the second and third together; the third rather longer than the fourth; the second twice as long as the first; the fifth slightly clubbed and abruptly truncated at the end, but not slit longitudinally; the others cylindrical. *Labial palpi* short, the third joint longer than the second, clavate and abruptly truncated at the end.

Thorax smooth; sides of the thoracic nota broad, concealing the epimera. *Pronotum* broadest behind, where its breadth is about equal to its length, the sides not projecting below those of the mesonotum, their lateral margins thickened; lateral furrows obsolete. *Meso-* and *meta-nota* much shorter, the lateral margins of the mesonotum thickened, but not those of the metanotum. *Metasternum* with a short conical

tubercle in the centre. *Wings* absent. *Legs* slender, the hind legs less than twice the length of the body. *Coxæ* of fore legs only, with a spine; those of the hind legs carinated on the outer side. *Femora* of the fore and middle legs unarmed, except a pair of distal spines; those of the hind legs slender, smooth, without any oblique ridges on the outer side, channelled beneath, armed with a row of six small spines on the inner inferior keel, and numerous very small and blunt ones on the outer; the distal spines quite blunt. *Tibiæ* of the fore and middle legs with two rows of four spines in each and a terminal pair: those of the hind legs are not expanded, the spines on them irregular, 11 to 13 in a row, some of them very small, the last pair very large; two pairs of terminal spines, the upper of which are the smaller. *Tarsi* without pads, four-jointed: the relative length of the joints is 1, 4, 2, 3—the third considerably shorter than the second in the fore and hind legs, but nearly equal to it in the middle legs.

Abdomen slightly compressed (in spirit). *Cerci* rather long, slightly curved, covered with short hairs and a few long bristles on the posterior side.

Colours (in spirit), rather pale brown, the thorax and abdomen variegated with yellowish-brown; posterior margins of pro- and meso-nota darker. Hind tibiæ and tarsi dark reddish-brown.

Length of body, 34mm.; of antennæ, 47mm.; of pronotum, 9mm.; of cerci, 8mm.; of maxillary palpi, 13mm.; of fore tibiæ, 13mm.; of hind tibiæ, 30mm.

Female differs from the male in the following characters:—

Head has the epicranium smooth; in the maxillary palpi the third and fourth joints are about equal, and the last joints of both the maxillary and labial palpi are rounded at the end.

Thorax: The lateral margins of the metanotum are slightly thickened.

Abdomen: The ovipositor is as long as the abdomen; it is stout, and but slightly curved.

Legs: The femoral spines of the hind legs are obsolete.

Length of body, 29mm.; of pronotum, 8mm.; of cerci, 5mm.; of maxillary palpi, 8mm.; of fore tibiæ, 11mm.; of hind tibiæ, 20mm.; of ovipositor, 20mm.

The antennæ are broken, and cannot be measured.

Art. XVI. — *On* Majaqueus æquinoctialis, *from Antipodes Island.*

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 1st August, 1894.*]

Last December Mr. A. W. Bethune, of the colonial steamer "Hinemoa," presented to the Canterbury Museum a fine specimen of the petrel *Majaqueus æquinoctialis*—known to sailors as the "stinker"—which he had obtained at Antipodes Island. The bird—which is a male—is entirely brownish-black, except the chin, which is white; and Mr. Bethune informs me that all the birds he saw were similar in plumage, and none had any white markings on the face. The legs and feet are black. The bill, when fresh, had the sides of the upper mandible and the tubes blue, the culmen and unguis black; the lower edge of the lower mandible was flesh-colour. The following are its dimensions: Length, 21in.; wing, 16in.; tail, 5½in.; bill, chord of culmen 2·2in., to gape 2·5in., height 0·55in.; tarsus, 2·55in.; middle toe, without claw 2·95in., with claw 3·6in. The nests are in holes, made in the side of a slope, which are hollowed out into a circular chamber at the end. In this chamber the nest is raised several inches from the bottom, leaving a circular ditch round it. A single egg is laid. The old birds were sitting on fresh-laid eggs in December, while in the following May the young birds were fully fledged, although still in their nests. These young birds had the plumage in every respect similar to that of the adult.

Art. XVII.—*Notes on New Zealand Land Planarians. Part I.*

By Arthur Dendy, D.Sc., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 1st August, 1894.*]

Up to the present year the number of species of land planarians described, or even recorded, from New Zealand has been extremely small, amounting only to three, one of which was described by Professor Moseley, and two by Captain Hutton. Thanks to the assistance of many friends who have collected and forwarded specimens I am now in a position to bring the total number of species found in New Zealand up to twenty. Of these, twelve appear to be new to science. Eighteen of

the species belong to the genus *Geoplana*, while there is one species of *Rhynchodemus*, and one of *Bipalium*. The *Bipalium* may, however, be certainly regarded as introduced, and it is very likely that the same may be the case with the *Rhynchodemus*, which was found in the same locality (Albert Park, Auckland), and appears to be identical with an Australian species. One of the species of *Geoplana* (*G. cærulea* var.) is also almost certainly introduced, being also found at Albert Park, Auckland, and being identical with a peculiar variety hitherto known only from gardens in Melbourne and Sydney.

The remaining seventeen species may, I think, be safely considered as indigenous. One of these, *G. sanguinea*, is identical with a very common Australian species; but there is no reason for believing it to have been introduced, as it has been found in various localities, and far inland. Another, *G. sulphurea* var., differs very slightly from a common Australian species. The remaining fifteen appear to be peculiar to New Zealand, though some of them very nearly resemble Australian species, and it must be a matter of opinion whether the slight differences existing are sufficient to justify specific separation. This is particularly true in the case of *G. purpurea*, which — externally at any rate — differs from the Australian *G. cærulea* only in tint of colour, and of *G. subquadrangulata*, which combines the characters of the Victorian *G. quadrangulata* and *G. ventropunctata*.

I take this opportunity of thanking the numerous friends mentioned below to whom I am indebted for the gift of specimens. As it is proposed to continue these notes as occasion offers, I shall be very glad to receive fresh material from any part of New Zealand. The worms are usually found under logs and stones in fairly moist situations, and may be at once recognized by their flattened shape when at rest, their slimy sticky surface, and their usually bright colours. They may be kept alive for some days in small tin boxes with closely-fitting lids, and packed with rotten wood or damp moss. They must be kept moist, and cardboard boxes should be avoided. When thus packed they can be sent alive through the post with little risk of damage, especially if care is taken to put only a few in each box. I would refer those who may be desirous of obtaining further information concerning the anatomy and habits of land planarians to a series of memoirs on the subject contributed to the Transactions and Proceedings of the Royal Society of Victoria, from the year 1889 onwards.

Geoplana sanguinea, Moseley, sp.

Cœnoplana sanguinea, Moseley, Quarterly Journal of Microscopical Science, n.s., vol. xvii., p. 285 (1877).
Rhynchodemus testaceus, Hutton, Trans. N.Z. Inst.,

vol. xii., p. 277 (1880). *Geoplana sanguinea*, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 363 (1887). *Geoplana rubicunda*, Fletcher and Hamilton, *loc. cit.*, p. 370 (1887). *Geoplana alba*, Dendy, Trans. R. S. Victoria, vol. ii., part 1, p. 75, figs. 10, 11 (1890).

Having examined numerous specimens from Victoria, New South Wales, and New Zealand, I have arrived at the conclusion that Moseley's *Cœnoplana sanguinea*, Hutton's *Rhynchodemus testaceus*, Fletcher and Hamilton's *Geoplana rubicunda*, and my own *G. alba* are all specifically identical, and I therefore propose to revert to Moseley's original name.

It is a curious fact that Captain Hutton was unable to find eyes in the specimens described by him, for a very closely allied eyeless species (*Geoplana typhlops*) occurs in Tasmania. I have, however, found the eyes in all the New Zealand specimens, from various localities, examined by me, and am therefore disposed to believe that they were simply overlooked, owing to their unusually sparse development in this species.

Localities.—New Zealand: Dunedin (Hutton); Wellington (Hutton); near Napier (coll., A. Hamilton, Esq.); Tarawera township (coll., author); near Auckland (coll., T. Steel, Esq.).

Geoplana triangulata, n. sp.

Body, when at rest, broad and very much flattened, but at the same time long and strap-shaped; often with a more or less pronounced median dorsal ridge; flattened or even very concave below; with thin translucent margins. When crawling, very active, and capable of great elongation, becoming correspondingly narrowed at the same time; tapering gradually in front and behind, but broader towards the posterior extremity; more or less triangular in cross-section. Eyes as usual in the genus; numerous, but very small, and rarely in more than single series; continued round the horse-shoe-shaped anterior tip.

The dorsal surface has a dark purplish-brown colour for the median two-thirds, or thereabouts, of its breadth. This colour shades off rather abruptly into a translucent marginal band of pale-yellowish colour, peppered with numerous minute specks of dark-grey. In the posterior portion of the body there may be a very narrow mid-dorsal stripe of darker colour. The anterior tip is pale pinkish-yellow. The ventral surface is pale-yellowish, thickly peppered with minute grey specks.

In spirit the body is broad and strap-shaped, bluntly pointed behind, and much more gradually tapering in front. The peripharyngeal aperture is situate at about the junction of the middle and posterior thirds, and the genital aperture is somewhat nearer to it than to the posterior extremity.

This is a large species, commonly attaining a length of some 4in. or 5in. when crawling. It is extremely common in the soil of gardens about Christchurch, being frequently turned up by the spade in association with earthworms—upon which it feeds—and also under boxes, &c., lying flat on the soil.

Localities.—Neighbourhood of Christchurch (coll., author); Ashburton (coll., H. Fooks, Esq.); Rapaki (coll., T. Bone, Esq.).

Geoplana triangulata, var. **australis,** nov.

This variety differs from the typical form of the species in the absence of the conspicuous speckles on the pale-yellowish margins and ventral surface. Only very faint traces of such speckles can be detected even in the living worm. In other respects it is indistinguishable from the typical form. All the specimens which I have seen from Dunedin belong to this variety, while all which I have seen from Christchurch—a large number—are abundantly speckled. A specimen of this variety in the Dunedin Museum is remarkable for its large size, measuring 8in. in length by $\frac{1}{3}$in. in breadth after preservation in the ordinary way in spirits of wine.

Locality.—Dunedin (coll., A. Hamilton, Esq., and author).

Geoplana traversii, Moseley.

Geoplana traversii, Moseley, Quarterly Journal of Microscopical Science, n.s., vol. xvii., p. 284 (1877).

I have not yet met with this species, which was obtained by the late Professor Moseley from Mr. W. T. Locke Travers at Wellington, in spirits.

Geoplana moseleyi, Hutton.

Geoplana moseleyi, Hutton, Trans. N.Z. Inst., vol. xii., p. 277 (1880).

I have not yet been able to reidentify this species, which was obtained from Dunedin.

Geoplana graffii, n. sp.

Body, when at rest, very broad and flat and rather abruptly pointed at both ends, which are difficult to distinguish. Under-surface very flat, and closely pressed against the substratum on which it rests. Upper surface sloping on each side to a median longitudinal ridge, so that the body is obtusely triangular in section, all sides of the triangle being very flat. When crawling, long and narrow, and more oval in section; narrower in front than behind. Large specimens measure as much as 57mm. by 3·5mm. when crawling. Eyes very numerous, and arranged, as usual, in a densely-crowded

patch on each side of the anterior end, and continued more sparingly round the tip.

The greater part of the dorsal surface is very dark purplish-brown, or sometimes nearly black, in colour. Along the median dorsal ridge is a narrow band of much paler brown, which carries a pair of very narrow, and more or less irregular, very pale greenish, bluish, or brownish stripes. The degree of development of these two very pale and narrow stripes varies much in different specimens, as also do their distinctness and distance apart. They may even degenerate into irregular marbling in the median dorsal band, and they appear to be due to a local strengthening and running-together of the small bluish specks mentioned below. Usually the lateral margins of the dorsal surface are occupied each by a narrow band of paler brown, but this is not always present. The whole dorsal surface is flecked with small specks and dashes of pale greenish-blue, clearly visible to the naked eye, and giving the animal a very handsome appearance.

The anterior extremity is dark-brown in colour. The ventral surface is somewhat paler brown than the dorsal, with a still paler, ill-defined median band. It is flecked all over with very minute specks of whitish or very pale blue, evidently corresponding to the blue specks on the dorsal surface, but more numerous, and smaller, being only just visible to the naked eye.

In spirit the dorsal surface is strongly convex and the ventral flattened; the posterior extremity is gradually sharp-pointed, and the anterior rather abruptly narrowed towards its horse-shoe-shaped termination. The peripharyngeal aperture is about central, and the genital about half-way between it and the posterior extremity. The colour of the dorsal surface becomes dark-grey, flecked with minute whitish specks, and with a narrow median band of pale yellowish-brown; usually also with narrow, pale margins. The ventral surface appears paler grey, with a narrow median pale stripe.

Localities.—Gardens in neighbourhood of Christchurch (very common, lying on bare earth beneath wood, &c.); Dunedin (coll., A. Hamilton, Esq.); Ashburton (coll., Messrs. Maine and Fooks); Chatham Islands (coll., Major Gascoyne, R.M.).

Geoplana cœrulea, Moseley, var.

Cœnoplana cœrulea, Moseley, Quarterly Journal of Microscopical Science, n.s., vol. xvii., p. 285 (1877). *Geoplana cœrulea*, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 361, pl. v., fig. 1 (1887). *Geoplana cœrulea*, Dendy, Trans. R.S. Victoria, vol. ii., part 1, p. 70; part 2, p. 29; pl. iv., fig. 7 (1890–91).

In November, 1892, I received from Mr. T. Steel three specimens of the curious blue-tipped variety of this common Australian species. Although collected in Albert Park, Auckland, these specimens were indistinguishable from those found in gardens near Melbourne, and they were probably introduced to both localities, as well as to Sydney, with plants from some habitat as yet unknown.

Geoplana purpurea, n. sp.

When crawling, long and very slender, tapering very gradually in front and behind; dorsal surface strongly convex, ventral not very much flattened; length, about 35mm.; breadth, 2·5mm. When at rest strongly convex dorsally, fairly flat ventrally. No special lateral surfaces are visible under any circumstances. Eyes as usual.

Ground-colour of dorsal surface rather dark reddish-purple, interrupted only by a very narrow median band of nearly white.

Anterior tip pinkish. Ventral surface paler purple, under a lens appearing very finely mottled in two shades. (In light-coloured specimens the dorsal surface may exhibit a similar mottling.)

In spirit the body is nearly oval in section, somewhat flattened beneath; the peripharyngeal aperture is situate at about the middle or even a little in front of the middle, and the genital aperture at about one-third of the distance from it to the posterior extremity.

Locality.—Ashburton (coll., Messrs. Maine and Fooks).

Geoplana inæqualistriata, n. sp.

When fully extended the single specimen was long and narrow, tapering gradually to each end, flattened ventrally and convex dorsally; about 66mm. long and 3mm. broad. Eyes minute, but very numerous, arranged as usual in a crowded patch on each side of the head-end, and continued in single series round the extreme tip.

Dorsal surface dark brownish-grey, with streaks of pale, dull yellow, as follows: A narrow median yellow stripe continues from end to end. On each side of this comes an uninterrupted band of dark-grey occupying about a quarter of the total width of the dorsal surface. The outer quarter of the width on each side is also of dark-grey ground-colour, but is interrupted by long, narrow, discontinuous, overlapping stripes of pale-yellow. Towards the margins the yellow streaks come to prevail over the grey, and thus appear to form the ground-colour.

Anterior extremity pink. On the ventral surface the yellow colour predominates, and thus forms the ground-colour,

which is streaked with abundant, irregular, discontinuous, narrow, close-set stripes of dark-brown. A very narrow band of ground-colour at each edge of the ventral surface is free from the dark streaks.

In spirit the dorsal surface is pretty strongly convex, and the ventral nearly flat; the peripharyngeal aperture is a little behind the middle, and the genital aperture about one-third of the distance from it to the posterior extremity.

Locality.—St. Albans Road, Christchurch. (One specimen found on asphalt path in garden; coll., author.)

Geoplana sulphurea, Fletcher and Hamilton, var.

Geoplana sulphureus, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 365 (1887).

Body, when crawling, very long and narrow, strongly convex on the dorsal surface, but capable of being much flattened when contracted. Eyes as usual (? round extreme tip), but in nearly or quite single series. The larger of two specimens was about 45mm. long and 2mm. broad when crawling.

Ground-colour of dorsal surface fairly bright, clear yellow, interrupted by four stripes of dark-brown. The inner stripes are very narrow, enclosing a very narrow median band of ground-colour. The outer ones are twice or thrice as broad, each lying about midway between the inner stripe of the same side and the lateral margin. Minute specks of brown are scattered over the ground-colour between the inner and outer stripes. Anterior tip dull pinkish-brown, ventral surface pale-yellow.

In spirit the body is long and narrow, nearly oval in section. One aperture was nearly central, the other was not seen.

This variety differs from the New South Wales specimens of *G. sulphurea* only in the presence of the brown speckles mentioned above.

Locality.—Albert Park, Auckland (coll., T. Steel, Esq.).

Geoplana splendens, n. sp.

When at rest, very broad and flat. When crawling, convex above and flat beneath, tapering very gradually at both extremities. Eyes very numerous at the sides of the head-end (extreme anterior tip of the single specimen injured). Length, when crawling, 41mm.; breadth, 4mm. Dorsal surface marked with three longitudinal stripes of emerald-green alternating with four stripes of dark, warm brown; with very narrow, pale-grey margins. The green stripes are rather narrower than the brown, and each is made up of an immense number of minute, brilliant metallic-green specks set in the dark-brown background. Ventral surface pale purplish-grey, without stripes.

In spirit the body is convex above, flat beneath, sharp-pointed behind, with the peripharyngeal aperture near the middle of the body, and the genital aperture about half-way between it and the posterior end.

Locality.—Jackson's, on the Teremakau River, west of Otira Gorge (coll., Miss Dendy).

Geoplana mariæ, n. sp.

The single specimen when at rest was coiled more or less into a knot; the body being thick and strap-shaped, with both surfaces flattened. When crawling it is long and narrow, tapering very gradually in front, much broader behind, while the dorsal and ventral surfaces may be both more or less convex or both flattened. The dorsal surface may even become concave by curling-up of the margins of the body. The posterior end appears thickened dorso-ventrally. Length when crawling, 97mm.; breadth, 5mm. Eyes unusually small and few, but with the usual arrangement, and continued round the anterior margin.

Ground-colour of the dorsal surface very pale brownish-yellow, thickly marbled with dark-brown speckles. In the mid-dorsal line a rather narrow, paler band, with less of the dark-brown marbling, but edged on each side by an ill-defined darker band, where the brown marbling is unusually strongly developed. Anterior tip pink. Ventral surface very pale yellow, sprinkled with brown in smaller specks than on the dorsal surface, and with a lighter median band, where the brown specks are smaller still. Margins speckled as elsewhere.

In spirit the body is strongly convex below, much flatter above, without prominent margins; a good deal broader behind than in front, and remarkably blunt at both extremities. The peripharyngeal aperture is situated at about the junction of the middle and posterior thirds, and the genital aperture very near to the posterior end, considerably nearer than it is to the peripharyngeal.

Locality.—Jackson's, on the Teremakau River, west of Otira Gorge (coll., Miss Dendy).

Geoplana agricola, n. sp.

Body, when crawling, long and narrow, strongly convex above, flat beneath; about 60mm. long and 3·5mm. broad. Eyes numerous, and arranged as usual.

Ground-colour of dorsal surface pale-yellow, interrupted by two broad bands of dark chocolate-brown, one on each side of the middle line, and rather broader than the intervening stripe of yellow ground-colour. The outer bands of yellow ground-colour are of about the same width as the median one, and are margined each by a very thin brown line situate at the

junction of the dorsal and ventral surfaces. (A few very minute specks of brown occur in each of the yellow stripes of ground-colour.)

Anterior tip bright pink. Ventral surface very pale yellow, mottled thickly with small specks of light, dusky brown. Three narrow longitudinal bands are almost free from the mottling; one of these is median, and the others are just inside the dark marginal lines.

In spirit the dorsal surface is strongly convex, while the ventral surface is concave, with slightly prominent margins. The peripharyngeal aperture is somewhat behind the middle, and the genital aperture slightly nearer to it than to the posterior end.

Locality.—Lincoln Agricultural College, beneath a heap of mangolds (one specimen; coll., P. Marshall, Esq.).

Geoplana laingii, n. sp.

When at rest, short and thick, slug-like, with convex dorsal and ventral surfaces, and narrow crinkled margins. When crawling, long and narrow, much flattened below; ridged on the dorsal surface so as to be triangular in cross-section; tapering gradually in front and behind; slimy and sticky as usual, but with the dorsal surface minutely rugose or warty (granulated) both when at rest (contracted) and when fully extended. This granulation seems to be a well-marked character of the species. Length when crawling, about 80mm.; breadth, 4mm. Eyes as usual, but comparatively small and few.

Ground-colour of dorsal surface yellowish-brown, finely mottled with darker tint of same. In the mid-dorsal line is a narrow band of dull orange. This orange band is divided into two by a very fine median line of darker brown, and is edged on each side by a fine but distinct black line. It is also very finely mottled with the darker brown tint which forms the fine median line.

Anterior tip pinkish. Ventral surface pale-yellow, finely mottled with pale-brown.

In spirit the body is very much contracted, short and thick, convex dorsally and ventrally. The peripharyngeal is situate at about the junction of the middle and posterior thirds, and the genital aperture about half-way between it and the posterior extremity.

Locality.—Foot of Lake Taupo, North Island, under stones (two specimens; coll., R. M. Laing, Esq.).

Geoplana spectabilis, n. sp.

When at rest the single specimen was broad, pretty strongly convex on the dorsal surface, flat on the ventral, tapering more gradually behind than in front. When crawl-

ing, strongly convex on the dorsal, and flat on the ventral surface, tapering gradually at both ends; about 35mm. long and 3·5mm. broad. Eyes rather few and small.

Colour of dorsal surface warm reddish-brown, almost chestnut, thickly mottled with small irregular specks of bluish-white. Towards the margins these specks become more abundant and confluent, so as to form the ground-colour, while the reddish-brown is reduced in proportion.

Anterior tip reddish-brown. Ventral surface white, thickly speckled with minute specks of reddish-brown. On each margin there is a narrow band of white almost free from speckles.

In spirit the dorsal surface is convex and the ventral concave with prominent narrow margins. The body is much broader behind than in front. The peripharyngeal aperture is far back, at about the junction of the middle and posterior thirds. The genital aperture was not made out.

Locality.—Wadestown, near Wellington, under a stone, in the bush (coll., R. M. Laing, Esq.).

Geoplana hamiltoni, n. sp.

When crawling, flat on the ventral surface; strongly convex, or sometimes triangular, on the dorsal; tapering gradually in front and behind; length, about 31mm.; breadth, 3mm. Eyes as usual.

Ground-colour of dorsal surface nearly white, finely streaked and marbled with chestnut-brown, and with a narrow but very distinct median stripe of darker brown. The fine brown streaks become concentrated towards the middle line, and on each side of the dark median stripe there is also a fine dusting of very minute, iridescent greenish specks.

Anterior tip reddish-brown. The ventral surface is paler, the ground-colour nearly white, finely marbled with rich chestnut-brown. The brown specks show a tendency to accumulate in an ill-defined mid-ventral stripe.

In spirit the body is short and thick, with narrow anterior tip. It is strongly convex on the dorsal surface, and very slightly convex on the ventral. The margins are without distinct "ambulacral line" further than the usual white ridges at the anterior extremity, and there are no special lateral surfaces. The peripharyngeal aperture is a very little behind the middle, and the genital aperture about half-way between it and the posterior end.

Locality.—Near Napier, Hawke's Bay (coll., A. Hamilton, Esq.).

Geoplana gelatinosa, n. sp.

The single specimen when at rest was very broad, flat, and extremely thin, with crinkled edges, and very abruptly

narrowed at the anterior extremity; about 28mm. long, and 8mm. broad. When crawling the edges of the body straighten out, and the dorsal surface becomes slightly elevated in a median ridge, but the body remains thin and translucent, the alimentary canal clearly showing through. It now tapers very gradually to the posterior end, and more suddenly in front. The animal was very inert, and it was difficult to make it crawl. When stretched out it measured about 50mm. by 6mm. Eyes as usual, very numerous in a densely crowded patch at each side of the head-end, and continued all round the extreme tip.

Dorsal surface dark olive-brown, with irregular, rounded splotches of a lighter colour, like the knots in wood. Minute pale metallic-green specks are scattered all over, but visible only with a lens, though groups of them are visible to the naked eye as small whitish specks. The pale-brown knot-like markings are somewhat aggregated in the middle line, and towards the margins. There is also a very narrow median stripe of lighter colour at the anterior end of the dorsal surface, but visible only for a very short distance. When stretched out a very narrow pale-brown margin, free from speckles, also becomes visible.

The anterior tip is brown, and the ventral surface is light yellowish-brown, finely speckled with dark-brown.

The colour and markings of the worm altogether formed a close imitation of the piece of wet rotten bark on which it lay at rest, and on which it was almost indistinguishable, looking like a mere slimy patch.

In spirit the body is pretty strongly convex above and slightly concave below, the smooth, narrow margins, free from speckles, being conspicuous on the ventral aspect. The peripharyngeal aperture is situated well behind the middle of the body, but still in the middle third, and the genital aperture is about half-way between it and the posterior end. The general colour of the worm changes to dull purple, while the lighter splotches on the dorsal surface become rusty red.

Locality.—Jackson's, on the Teremakau River, west of Otira Gorge (coll., Miss Dendy).

Geoplana subquadrangulata, n. sp.

When at rest broad and much flattened on the dorsal surface, with no median ridge, with well-marked lateral surfaces sloping slightly inwards to the ventral surface. More or less quadrangular in transverse section, with sharp angles between the dorsal and lateral surfaces, but no sharp distinction between lateral and ventral. Rather abruptly pointed at each end. When crawling the body becomes long and narrow, and the sharp distinction between dorsal and lateral surfaces

disappears, so that it becomes oval in section, with convex dorsal surface. The dorso-lateral margins may, however, be turned upwards, so as to form a trough on the back of the animal. I have seen this happen when one specimen is crawling along the top of another, the upper one being partly enclosed in the trough. Eyes small and rather few, but continued abundantly round the horse-shoe-shaped anterior tip. Length when crawling, about 28mm.; breadth, 2·5mm.

Two pattern varieties are about equally abundant, but intermediate ones are also met with, and both are found in the same localities:—

(*a.*) Ground-colour of the dorsal surface warm brown, mottled with a darker shade. The mottling is intensified to form three dark-brown stripes, one very narrow median and a pair of much broader ones, one just inside each dorso-lateral margin. Lateral surfaces pale-brown, more or less mottled with the darker tint, the mottling sometimes forming an ill-defined stripe beneath a lighter marginal band.

Anterior tip brown. Ventral surface pale-brown, finely mottled all over with a darker tint, but not so dark as on the dorsal surface.

(*b.*) Characterized by the sharper definition of the three dark stripes and the more or less complete absence of mottling from the pale-yellow ground-colour.

In spirit the quadrangular shape is well marked; the peripharyngeal aperture is a little behind the middle, and the genital aperture about one-third of the distance from it to the posterior end.

Localities.—Gardens near Christchurch (both varieties abundant; coll., author). Ashburton (both varieties common; coll., Messrs. Maine and Fooks). Dunedin (speckled variety; coll., A. Hamilton, Esq.). Bluff (a variety with two extra fine dark stripes on each side, and with speckled ventral surface; coll., author).

Geoplana tenuis, n. sp.

The single specimen, as it lay at rest, was very long and narrow, and coiled up. When crawling it was also very long and narrow; strongly convex above, somewhat flattened beneath. The body was occasionally drawn in so as to become comparatively short and broad. The anterior tip was slightly injured, but numerous eyes were visible.

Ground-colour of the dorsal surface bright grass-green, with five dark-green stripes. A very narrow but well-defined median stripe is almost black; on each side of this comes a broad band of ground-colour; then a less sharply-defined stripe of very dark green, two or three times as broad as the median one; then a band of ground-colour of about equal

width; then, just above the junction of dorsal and ventral surfaces, a rather narrow, ill-defined stripe of moderately dark green, followed by another narrow band of ground-colour. When viewed from above the first-mentioned pair of dark-green stripes appear almost marginal, the others being more lateral than dorsal.

The ventral surface is pale yellowish-green, darkening at the margins to form yet another pair of ill-defined stripes bounding the creeping-sole.

In spirit the body is approximately oval in transverse section, and the creeping-sole occupies little more than half the breadth of the ventral aspect. The body is broader in front than behind, and tapers off gradually to the posterior end, which has been broken off short. Both apertures are well forward—the peripharyngeal at about the junction of the anterior and middle thirds, the genital nearly in the middle of the body. The specimen appears, however, to have contracted rather unequally, and, as already mentioned, the posterior extremity is injured. In spirit it measures 28mm. in length and 3mm. in greatest breadth.

Locality.—Nelson (in the bush; coll., R. I. Kingsley, Esq.).

Rhynchodemus moseleyi, Fletcher and Hamilton.

Rhynchodemus moseleyi, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. ii., p. 371 (1887).

In November, 1892, I received from Mr. T. Steel four specimens of a small *Rhynchodemus* which I identify with this species. They were about 21mm. long when crawling. The dorsal surface was black to the naked eye, but appeared minutely speckled with white under a lens, and some specimens showed a darker median line. The ventral surface was white, or slightly speckled. They were collected in Albert Park, Auckland, and have quite possibly been introduced from Australia.

Bipalium kewense, Moseley.

Bipalium kewense, Moseley, Annals and Magazine of Natural History, ser. 5, vol. i., p. 237 (1878).

This species, which has been so widely distributed by the unintentional agency of man, and whose natural habitat is still unknown, was also obtained by Mr. T. Steel in Albert Park, Auckland.

Art. XVIII.—*Note on a New Variety of* Peripatus novæ-zealandiæ, *Hutton.*

By Arthur Dendy, D.Sc., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 5th September, 1894.*]

Through the kindness of Mr. H. Suter I have recently received three specimens of *Peripatus* from Stratford, in the North Island of New Zealand, a locality from which *Peripatus* has not, so far as I know, been hitherto recorded. The specimens were given to me in spirits of wine, in an admirable state of preservation, having evidently been killed by drowning. They are of remarkably large size, one in particular measuring 2¼in. long in its present state (exclusive of the antennæ), and being broad in proportion.

Their most remarkable peculiarity, however, lies in the fact that they all possess sixteen pairs of claw-bearing legs, instead of the usual fifteen. This is a very remarkable fact, for no Australasian species of *Peripatus* has yet been found to vary in the number of its appendages, although many, especially of *P. novæ-zealandiæ*, have been examined. Sedgwick says, in his monograph of the genus, "The number of legs are constant in all specimens" in the Australasian species. He further gives this number as fifteen pairs. I have already shown, however, that a Victorian species, which I have described under the name of *P. insignis*, has only fourteen pairs, and now we have a variety of the New Zealand species with sixteen. Hence the exact number of the legs can no longer be regarded as a distinguishing character of the Australasian species.

Through the kindness of Captain Hutton and other friends, I have been enabled to examine a considerable number of specimens of the ordinary New Zealand form, with fifteen pairs of legs, coming both from the North and the South Island. I have also carefully dissected, and examined the external characters, including the jaws, of the new variety, and can detect no point of difference except in the large size and the number of legs. The general colour of the three specimens is dull indigo-green, varied with more or fewer orange-coloured papillæ. It is interesting to note that, in spite of the increased number of legs, the genital aperture is still situated between those of the last pair, and the special nephridial apertures are still on the fourth and fifth legs; hence, one is inclined to suppose that the new pair of legs has been intercalated somewhere between the fifth and the fifteenth of the ordinary form.

I had hoped to obtain some evidence as to the time of the appearance of the extra legs from the examination of embryos, but, although both the specimens which I dissected were females, I could find no embryos in a sufficiently advanced state of development to afford the required information.

Had it not been for the well-known variability of certain neotropical species in the number of their legs I should have been inclined to regard the three specimens from Stratford as specifically distinct. Under the circumstances, however, it seems best to regard them as belonging to a local variety, and I propose for this variety the name *Peripatus novæ-zealandiæ*, var. *suteri*.

Art. XIX.—*Notes on a New Zealand Land Nemertine.*

By Arthur Dendy, D.Sc., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 5th September, 1894.*]

The nemertines form, as is well known, a typically marine group of animals, being abundant and widely distributed in shallow seas. Very few species seem to have deserted their marine habitat in favour of a terrestrial one, so that land nemertines are exceedingly rare. Up to the present time, indeed, only five species have been described—viz., *Tetrastemma agricola*, discovered on the "Challenger" Expedition, and described by Dr. Von Willemoes-Suhm; *Tetrastemma rodericanum*, discovered at the Island of Rodriguez by the Transit of Venus Expedition, and described by Mr. Gulliver; *Geonemertes palaensis*, found by Professor Semper in the Pelew Islands; *Geonemertes chalicophora*, found by Professor Von Graff in gardens in Germany, and probably introduced there by human agency; and lastly, *Geonemertes australiensis*, discovered by myself in Victoria, and described with anatomical details and illustrations in the "Proceedings of the Royal Society of Victoria" for 1891.

Like the land planarians, to which they are in some measure related, the land nemertines belong to the cryptozoic fauna, being found under fallen timber, stones, &c., and probably only venturing from their hiding-places at night or in very wet weather in search of prey. They are small, slimy worms, closely resembling land planarians at first sight, but readily distinguished by the sudden emission of a long, white proboscis from the anterior extremity when the animal is irritated.

Having been much interested in these animals in Victoria, I have naturally been on the look-out for them since my arrival in New Zealand, and I have recently found two specimens of an indigenous land nemertine, not, unfortunately, in their native habitat, but put away in spirits amongst collections of land planarians.

The first specimen I found in a small jar of land planarians collected in various unspecified localities in New Zealand, and most kindly given to me by Mr. Suter. The presence of only four eyes in this specimen, and the characteristic arrangement of alternate dark and light bands on the dorsal surface, clearly indicated that it was specifically distinct from *Geonemertes australiensis*, although the sections (cut by the usual paraffin method) showed a close agreement in general anatomical features. Unfortunately the proboscis was missing, it having been doubtless everted and broken off, as so frequently happens when nemertines are placed in alcohol.

Thinking that there might possibly be specimens of land nemertines similarly put away amongst other worms in the Canterbury Museum, I appealed to Captain Hutton, who immediately looked through the collection of worms in spirit for me, and gave me a bottle labelled, "Land Planarians, Toitoi, Southland; Miss J. G. Rich." For this and much other kind assistance of a similar nature I desire to express my great indebtedness to Captain Hutton.

On examining this small collection of land planarians from Toitoi I found another specimen of *Geonemertes*, with the pattern on the dorsal surface much fresher-looking and more distinct, but otherwise identical with Mr. Suter's specimen. Moreover, in this case, the proboscis, although it had been everted and cast off, was found in the bottle.

Thanks to the discovery of this second specimen, I am now in a position to give a sufficient description of this New Zealand land nemertine to serve for purposes of specific determination, and I propose to name it

Geonemertes novæ-zealandiæ, n. sp.

The larger specimen (in spirit) was a little less than 1in. in length and about $\frac{1}{8}$in. in diameter. It was nearly oval in transverse section, but somewhat flattened ventrally, terminating bluntly in front and behind, and with an aperture at each extremity. The surface was transversely wrinkled, more strongly dorsally than ventrally. Two dark spots, one at either side of the blunt anterior extremity, seemed to indicate the position of the eyes, but these, being deeply imbedded, were not clearly visible until sections were cut.

The colour was pale, dull yellow, with alternate light and dark longitudinal bands faintly visible on the dorsal surface,

and arranged as follows: There is a median broad light band; on each side of this comes a broad dark band of about the same width; then comes a light band of about half the width; and this is followed on the outside by a very narrow dark band, situate at about the junction of the dorsal and ventral surfaces. Thus it appears that there are four dark bands or stripes—viz., a pair of inner broad ones and a pair of outer narrow ones.

The second and somewhat smaller specimen, collected by Miss Rich, agreed exactly with the first in external characters, but, being apparently fresher, the dark bands on the dorsal surface still retained a rich chocolate-brown colour, the other parts of the body being of a pale-yellow.

In sections stained with borax-carmine and cut by the paraffin method I could only detect four eyes, situated deeply beneath the epidermis of the rounded anterior extremity. These are arranged in two pairs, those of the one pair being considerably larger than those of the other, and placed a little more anteriorly and ventrally. The smaller ones were difficult to make out satisfactorily, because the pigment appears to have been dissolved by the action of the alcohol; the large ones were very distinct, with the usual pigmented cup. With regard to its eyes, therefore, *Geonemertes novæ-zealandiæ* conforms to the more usual condition met with in land nemertines, and differs markedly from the Australian species.

Other anatomical characters, so far as I have been able to make out from the limited material at my disposal, agree very closely with those of *G. australiensis*.

The mouth opens into the rhynchodæum (in other words, there is only a single aperture for mouth and proboscis-sheath).

Lateral organs, including cephalic pits, are well developed, and appear to closely resemble those of *G. australiensis*.

The nervous system, muscular system, and alimentary canal do not seem to depart from the usual type.

The structure of the proboscis, with its marvellous armature, appears also to agree closely with that of previously-described species. The calcareous stylets have the usual form, and I detected four reserve-sacs in the usual position. Probably, however, this number is not constant.

The sexes are probably distinct, for in the specimen of which I cut sections I found abundant ova, but no spermatozoa.

A very strongly developed "cephalic gland" occurs in the same position and with the same histological structure as in *G. australiensis*, to the account of which species I would refer the reader for further particulars as to the habits and anatomy of these remarkable worms.

Certain minor histological differences will probably be found to exist between the two species, as, for example, the occurrence of numerous peculiar, round or ovoid, thick-walled, nucleated bodies just within the longitudinal muscle-layer of the body wall in *Geonemertes novæ-zealandiæ;* but these are details into which I cannot enter at present.

Art. XX.—*Notes on New Zealand Echinoderms.**

By H. Farquhar.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

Plates X.–XII., and XIII. (in Part).

In the following notes I have attempted to add a little to our knowledge of the habits of our commonest Echinoderms, to clear up some of the confusion in which, unfortunately, they have become involved, and to direct the attention of New Zealand naturalists to a much neglected, but exceedingly interesting, group of marine animals. The Asteroids which I have described as new species may be known already from some other part of the world, as even the littoral forms often have a wide geographical range. The dearth of works of reference, which is one of the greatest difficulties in natural-history work in the colonies, prevents my ascertaining with certainty that they have not been found elsewhere. I believe that they are new to science, but if my names have to give place to older ones I venture to hope that the descriptions and figures will still be of some use.

Evechinus chloroticus, Valenciennes.

This is the common sea-egg, the *kina* of the Maoris. It is by far our commonest and most characteristic sea-urchin, being found in abundance on the reefs, and on stones in shallow water (0 to 12 fathoms), all round the New Zealand coasts, both inside and outside the harbours. Where the rock is soft it excavates hollows for itself; elsewhere its favourite resorts are the rock crevices and overhanging sides of rock-pools. Opposite the entrance of the Nelson Harbour a broad belt of

* These notes are not supposed to be by any means exhaustive, and no one can possibly be more conscious of their deficiencies than myself. I trust, however, that they may be the means of leading others to collect these beautiful animals, and record their habits. A collection, or even a list of species, from Auckland or the Bay of Islands, for instance, would be of immense interest.

reef formed of soft sandstone fringes the shore, forming a comparatively level floor, a miniature "plain of marine denudation," intersected by numerous narrow clefts, which are never free from water at the lowest tides. When I was a boy I have often observed great numbers of this species along the sides of these clefts, just below low-water mark, in rounded cavities which they had themselves hollowed out of the soft rock. Mr. E. Lukins, of the Port, Nelson, has kindly verified this observation for me recently. The Maoris collect large numbers, which they cook and use for food. Numerous broken and denuded tests may be found on the shores after storms. This species varies considerably in form, some specimens being much more depressed than others. Many are circular when viewed from above, while others are more or less pentagonal.

The range of this species is interesting and somewhat remarkable. It does not occur in Australia, where many of our Echinoderms have been found, but specimens were collected by the naturalists of the "Challenger" Expedition at the Fiji Islands. If this stood alone it would be simply one of those interesting facts which our present knowledge is inadequate to explain. When, however, we consider it in connection with the fact that a large number of our plants and animals, some of which are eminently characteristic of the New Zealand region, have representative forms in Norfolk Island, Lord Howe Island, and New Caledonia, the distribution of our sea-urchin assumes an important significance, reminding us of times long ago—probably early Pliocene—when the continent of which New Zealand of to-day is but a remnant extended far to the north and west. The southern branch of the south tropical current, which passes the Fiji Islands and sweeps down the eastern coast of Australia, was then deflected southwards by this northern extension of New Zealand, and facilitated the diffusion of Polynesian plants and animals to New Zealand.*

E. chloroticus has been found fossil in Pliocene formations at Wanganui.

Although our species does not occur in Australia there is a very closely allied form found there, *E. australe*, described by the Rev. J. E. Tenison-Woods from specimens obtained near Port Jackson (Proc. Linn. Soc. N.S.W., vol. ii., p. 167, and Dr. Ramsay's Catalogue Ech. in the Aust. Mus., pp. 24, 53). It appears to be rare, and, unlike the New Zealand form, does

* For proofs of the former extension of New Zealand, and affinities of our fauna and flora, see "Proofs of the Subsidence of a Southern Continent during Recent Geological Epochs," by M. Blanchard, N.Z. Journ. of Science, vol. i., 1883; and "On the Origin of the Fauna and Flora of New Zealand," by Professor Hutton, *ibid.*, vol. ii., 1884.

not live near low-water mark, and seems to have a very limited range.

The only other known species of this southern genus is *E. raritubercula tus* (Bell, Ann. and Mag. Nat. Hist., ser. 5, vol. xx., p. 403), the locality of which is not known. We may expect to find it in New Zealand, and collectors should look out for specimens. It may be easily overlooked, however, living specimens being doubtless very similar to small specimens of *E. chloroticus*.

I have a strangely-deformed test of *E. chloroticus*, which shows how even a sea-urchin is capable of adapting itself to new conditions. The upper part of the test was broken away when I picked it up on the beach. It had a strange irregular appearance, and when I counted the ambulacral and interambulacral areas I could only find four, instead of five, the usual number. On rubbing away the spines, however, I found that one of the poriferous zones only extends to the summit of a prominent excrescence on one side of the test about 12mm. from the actinosome; beyond this there is a shallow depression where the two interambulacral areas meet and form one broad, flattened zone. It had evidently been jammed among the rocks, and, being unable to grow in its regular rounded shape, had formed the above-described abnormal test.

Echinus magellanicus, Philippi.

This species ranges throughout the southern ocean and to the Philippine Islands, and in depth from 10 to 1,600 fathoms. It appears to be pretty generally distributed around the New Zealand coasts. I have taken specimens with the dredge in Wellington Harbour, from a rocky bottom, in about 10 fathoms of water. It has been found fossil in Pliocene formation at Shakespeare Cliff, Wanganui.

Echinocardium australe, Gray.

In the Ann. and Mag. Nat. Hist., ser. 2, vol. vii., 1851, p. 131, Dr. Gray described specimens of *Echinocardium* from Australia and specimens from New Zealand as two distinct species—*E. australe* and *E. zealandicum*—but Mr. Agassiz has united them under the name *E. australe* ("Revision of the Echini," p. 109). No doubt the typical *E. australe* does occur here (Professor Hutton mentions a large specimen from Chalky Inlet, Trans. N.Z. Inst., vol. xi., p. 307), but the form which is exceedingly abundant in Wellington Harbour appears to be at least a well-marked variety, and when a good series of both forms have been carefully compared it is not improbable that they may be found to be distinct species. I have taken many specimens with the dredge in Wellington Harbour—in fact, the dredge never comes up from a muddy

bottom without a dozen or more in it, and fishermen often bring them on shore in their nets. The only specimen of *E. australe* from elsewhere with which I have been able to compare my specimens is one in the Colonial Museum from Port Jackson, from which they differ considerably in size and shape. My largest specimens hardly exceed half the size of that from Australia. They are all relatively broader except very young individuals, and far more depressed anteriorly. This last difference is very striking and distinct. A comparison of good series of specimens and the results of a detailed examination of the minute structure of both forms is very much needed.

Arachnoides placenta, Linnæus.

This cake urchin is one of our commonest Echinoderms. It may be found at low water on sandy beaches and on mud-flats in the harbours. Although in Australia it only occurs within the tropics* (north of Wide Bay), in New Zealand it extends as far south as Dunedin—46° south lat. It is the only Clypeastid known certainly to inhabit the New Zealand seas, for, although *Peronella rostrata* has been said to occur here, there is a want of evidence of the occurrence. If the specimen of *A. placenta* in the Australian Museum from California was found there this species has a very interesting distribution, and will probably be found in many other parts of the Pacific. It has been found fossil in Pliocene formations at Wanganui, Castle Point, and Awamoa.

Ophionereis schayeri, Müller and Troschel.

The diameter of the disc is about 20mm., and the length of an arm about six times the diameter of the disc. The arms increase in width from the disc outwards for a short distance, the greatest width without the spines being about 3mm.; beyond this they remain about the same width, or taper very little, to a third of their length, and thence taper evenly to a fine extremity. The disc is rather tumid, circular with a wavy margin, covered above and below with exceedingly small imbricating scales, which are larger on the margin of the disc, especially near the radial shields. The radial shields are very small, irregularly ovate, and distant. The mouth papillæ are usually eight to each angle; they are short, stout, blunt, and close-set, the two at the apex being smaller than the others. The teeth are five in number on each angle, bluntly pointed, vertically compressed, with glassy tips, except the lowermost, which is rounded and smaller than the rest. The mouth-shields are large, and rudely ovate or shield-shaped, and the

* Dr. Ramsay's Cat. of Ech. in the Aust. Mus., p. 54.

side mouth-shields small, curving round the mouth-shield, and narrow within, where they do not meet. The under arm-plates are squarish, with slightly re-entering curves on the outer side and laterals. The side arm-plates are small, and widely separated above and below. The upper arm-plates are about twice as broad as long, broader within than without, having a rounded edge within and a re-entering curve without; they are sometimes split in two. The supplementary plates are rather large, broader without than within, and sometimes in several pieces. The arm-spines are four in number on the side arm-plates near the disc, and usually three on the plates of the outer part of the arm; they are stout, blunt, slightly tapering, and laterally compressed. There is one large roundly-oval tentacle-scale to each pore. The colour is purplish-black or grey, the rays being usually banded and the disc variegated or splashed with light-grey or yellowish-white.

In the Proc. Zool. Soc., 1872, p. 811, and Cat. Ech. of N.Z., p. 2., Professor Hutton briefly described this species under the name *Ophionereis fasciata*. Mr. Lyman, when revising the group for the "Challenger" Report, doubtfully placed *O. fasciata* as a synonym of the Australian species, *O. schayeri*. Through the kindness of Mr. Etheridge, of the Australian Museum, I have been able to compare specimens of *O. schayeri*, from Australia, with New Zealand specimens, and I find that they are certainly identical.

This is by far the commonest Ophiuroid found near Wellington, and probably the commonest of all the New Zealand forms. It is exceedingly abundant under stones in rock-pools between tide-marks, and just below low-water mark. Its colour is apparently protective, corresponding almost exactly with that of the stones and sand among which it lives.

Ophiopeza cylindrica, Hutton.

Professor Hutton briefly described this species under the name of *Ophiura cylindrica* (Cat. Ech. of N.Z., p. 3, 1872). Mr. Lyman, in his monograph, "Challenger" Report, vol. v., p. 15, has made *O. cylindrica* a synonym of *Pectinura rigida*, Lyman. In the original description of *P. rigida* (Bull. Mus. Comp. Zool., Harvard, vol. iii., p. 224) it is said to have been found at Zanzibar, but in the "Challenger" Report the locality given is Fiji. A comparison of the two descriptions, and the localities—Zanzibar, Fiji, New Zealand—seemed to indicate that there was an error somewhere. I have therefore compared Mr. Lyman's description of *P. rigida* with the type specimens of *O. cylindrica* which are in the Colonial Museum, Wellington, and I find they are quite distinct from

Mr. Lyman's species: in fact, they belong to a different genus,—*Ophiopeza*,—being without supplementary mouth-shields, and having but two genital openings to each inter-brachial space. I have collected a number of specimens belonging to this genus near Wellington, among seaweeds on the rocks, a little below low-water mark. These I at first mistook for specimens of a new species, but I find by comparing them with the type specimens of *O. cylindrica* that they are small individuals of that form.

Ophiothrix cœrulea, Hutton.

This species was described by Professor Hutton from specimens in the Colonial Museum. He subsequently found, however, that they had been brought with a number of other natural-history specimens from Fiji. This species must therefore be omitted from our list.

Ophiomyxa australis, Lütken.

This species is not uncommon on the rocky parts of the coast near Wellington, in shallow water, among the roots of Laminarians. There are also two specimens in the Colonial Museum from Dunedin. It has been collected by Mr. H. B. Kirk at Stewart Island.

Asterina regularis, Verrill.

This cushion-star is the commonest New Zealand Asteroid. It is abundant on all the rocky parts of the coast near low-water mark, and numerous in rock-pools, and on piles and sea-walls in the harbours. This species varies much in colour, form, and size. Greenish-grey varieties are perhaps the commonest, although yellow, orange, purple, and dull-green variegated with yellow are also abundant; dark-purple and many shades of blue frequently occur. In some specimens the five rays are more prominent than in others. I found two specimens at Ohiro Bay with six rays each, and one of them had two madreporiform plates. It also occurs on the east coast of Australia, but appears to be rare there, the common form being an allied species (*A. gunnii*).

Stegnaster inflatus, Hutton.

This appears to be rather a rare species. I have found one specimen at Ohiro Bay, attached to the underside of a stone in a rock-pool. It is smaller than the type in the Colonial Museum; it is, however, brilliantly coloured and handsomely marked, being rich orange above spotted with deep dull-red and dark-grey, and white variegated with reddish-orange beneath. There is a specimen in the Canter-

bury Museum from Wellington, and one from Nelson in the Otago Museum. Mr. H. B. Kirk informs me that he has occasionally seen specimens on the coast near Wellington at low water, and I have seen a fine specimen collected by Mr. A. Haylock at Lyall Bay, the abactinal surface of which is dull reddish-purple variegated with white and a few spots of deep madder-brown, and white variegated with purplish-grey beneath.

Astrogonium pulchellum, Gray.

This fine species is not common in New Zealand waters. It appears to frequent sheltered bays and harbours, on a stony or sandy bottom. I have received a very fine specimen from Mr. Cecil Howard, of Christchurch, which was brought on shore in a fisherman's net at the Bluff. It measures 54mm. from the centre of the disc to the tips of the rays. I have also a specimen from the Wellington Harbour of what Professor Hutton has called "variety B" (Cat. Ech. of N.Z., p. 8), which is much smaller than typical specimens of *A. pulchellum*. The most striking differences, however, are in the apical plates. These are very little swollen, although longer than the other marginal plates. In typical specimens of this species the apical plates are much swollen, forming the most striking character of the species, and I have seen young specimens about the same size as specimens of the variety, with these plates very prominent, contrasting strongly with the same plates of the variety. Outside of these plates in the variety there are three other rather small but distinct and fairly well developed plates—two broad ones below, and a smaller one, which is very prominent, above. Typical specimens usually have one or two supplementary plates outside the large swollen apical plates, but these are always quite rudimentary. These differences are so well marked that when good series of both forms are obtained and compared it may be necessary to separate them and establish a new species for the smaller form.

Asterias (Strolasterias) calamaria, Gray.

This widely ranging species is exceedingly abundant in Wellington Harbour. It may be found on rocks and stones from low-water mark to 10 or 12 fathoms. When I first began to observe this starfish I came to the conclusion that two species had been grouped under one name, for I found that blue specimens and specimens marbled with blue may be obtained from deep water, but rarely, if ever, from near low-water mark; while brown, yellowish-brown sometimes marbled with reddish-brown, and grey specimens may be

found in abundance just below low-water mark. I also examined a great number of specimens brought on shore in fishermen's nets, but only on one occasion did I find a blue one among them. This difference in colour may be due to difference of sex. Professor Agassiz observed that the males and females of the common American starfishes—*Asterias vulgaris* (*Asteracanthion pallidus*, Ag.), and *Asterias forbesii* (*Asteracanthion berylinus*, Ag.)—can be distinguished by their different colour—"all those having a bluish tint being invariably females, a reddish or reddish-brown colour indicating a male"—and we may find that the same obtains in our species.* This appears also to explain the fact that I have never found any young specimens, the smallest being nearly half-grown individuals brought on shore by fishermen. If the young are sufficiently developed when born to attach themselves, as is the case with some southern forms, they probably remain with the females in deep water till they are well grown. During the summer I found plenty of large brown and grey specimens just below low-water mark, but in the winter they had retired to deeper water, out of the reach of the winter storms, and after a careful search I only found a single large specimen: this was, however, a specially interesting one. The spines on the abactinal surface, instead of being isolated, rather long, and pointed, are short, thick, and clavate, and arranged in clusters and irregular lines like the spines of a *Stichaster*. Dr. Lütken suggests that division may take place in this species (Ann. and Mag. Nat. Hist., ser. 4, vol. xii., p. 329), but I do not think it is so. Some of the rays get broken off, and are restored, but this is common to many species, and is merely the result of accident. There are usually eleven rays, though ten-rayed forms are not uncommon, and occasionally specimens having a greater or less number of rays may be met with. Recently I examined thirty-one specimens which had been left on the beach by a fisherman, where he had drawn his net on shore, and I found that twenty-six of them had eleven rays each, and the other five had ten rays each. A specimen which I had drying gave out white phosphorescent light where one of the rays had been broken.

* Since the above was written I have dissected eight specimens of this species obtained at low water in Wellington Harbour, with the following result: Five of them were males, having cream-coloured spermaries containing spermatozoa; and the other three were females with bright-orange ovaries full of eggs. They were all reddish- or greyish-brown specimens, with eleven rays each. One of them was a very large specimen, measuring 15in. between the tips of the rays. The reason why the difference of colour corresponds with the different habitat still remains to be discovered. I hope, however, to obtain some blue specimens shortly, so as to be able to solve the riddle.

Asterias (Strolasterias) scabra, Hutton. Plate XIII., figs. 3 and 4.

This fine species is the largest of all the New Zealand starfishes, except, perhaps, a large, yellowish *Echinaster*, apparently undescribed, numbers of which may be sometimes found at low water on the rocks at Lyall Bay and Island Bay in December and January. This is, perhaps, the species mentioned by Professor Hutton in the Trans. N.Z. Inst., vol. xi., p. 306; but, although it attains a very large size, it is not nearly such a handsome starfish as *Asterias scabra*. Specimens of *A. scabra* measuring 18in. between the tips of the rays are frequently met with, and I have heard that much larger ones have been found. This species also belongs to Mr. Sladen's sub-genus *Strolasterias*, having isolated spines on the abactinal surface, surrounded by thick, raised wreaths of pedicellariæ. The rays are long and well rounded above, with five longitudinal series of abactinal spines. These are often obsolete, especially on the apical part of the rays. The thick tubercle-like bunches of pedicellariæ, however, are always present, arranged in regular, longitudinal rows. The thick skin which covers the abactinal and lateral plates also covers the basal half of the exterior spine of the three which form an oblique line on the marginal plates, with a bunch of pedicellariæ on the superior side of the spine. The most striking characteristic, however, of this species is the colour of the large tube-feet, which are bright vermilion, with yellow terminal discs. The colour of the abactinal surface is greenish- or bluish-grey, brown, or purple, frequently variegated with reddish-brown. The madreporite is large and white. Large forcipiform pedicellariæ on short, fleshy stalks are numerous on the abactinal surface, scattered between the spines, and a few of the same kind on longer stalks in the ambulacral furrows. The number of rays is almost always seven; I have, however, seen one specimen with eight. Unlike its congener, *A. calamaria*, it does not frequent the harbour, but loves to be in the wash of the waves, where they break on the exposed, rocky parts of the coast.

The pedicellariæ of this species figured on Pl. XIII. are from drawings by my friend Mr. H. B. Kirk. Fig. 3 represents the small, forficiform pedicellariæ, which form bushy wreaths round the spines; and fig. 4 represents the large kind, which are scattered on the abactinal surface.

Stichaster australis, Verrill.

This species may be frequently found at low water, on the rocky coast near Wellington. One must search very carefully, however, to obtain specimens, as they hide away in the crevices of the rocks, and they are of a dark-grey colour.

They attach themselves so strongly by their numerous tube-feet that some of the rays of a specimen, although they are very stout, may be torn off in attempts to detach it from the rock. I have found a paper-knife useful in detaching specimens of this and other species without injuring them.

Stichaster insignis, sp. n. Plate XIII., fig. 1.

Rays 6, rarely 5 or 7. R = 52mm.; r = 5mm. to 7mm. Breadth of a ray near the base, 10mm. to 12mm.

The disc is small, flat or slightly tumid, and usually ovate in form. The rays are elongate, cylindrical, tapering, and laterally constricted at the junction with the disc. The madreporiform plates, which are numerous—usually four in number—are small, and surrounded by a wreath of spinelets. The plates on the rays are arranged in regular longitudinal series. They consist of a median series of large, broad, rudely quadrangular plates, succeeded on either side by three (in small specimens two) series of small plates, and a series of large, very broad lateral plates, broader than those of the median series. Between the lateral plates and the adambulacral plates there are two series of actinal intermediate plates, those adjacent to the lateral plates being much larger and broader than those adjacent to the adambulacral plates. The armature of the abactinal and lateral plates consists of short, stout, slightly clavate, subequal spinelets, with granular summits. On the plates of the median series there is an angulated line of spinelets, frequently with two or three spinelets within the angle. The small plates between the median and lateral series bear each a line or group of two or three spinelets. On the lateral plates there is a line or group of three or four spinelets on the abactinal (superior) part of each plate; then follows a bare region succeeded by one or two spinelets on the actinal (inferior) margin of the plate. The spinelets on the actinal intermediate plates are far larger and stouter than those on the abactinal and lateral plates. There are three forming an oblique line on the plates of the outer series, and one on the small plates adjacent to the adambulacral plates. All the plates are covered with rather thick skin, on which there are numerous, small, scattered, isolated, sessile, forcipiform pedicellariæ. The adambulacral plates carry two rather short, obtuse, cylindrical, divergent spines, the inner one being slightly stouter than the other. The ambulacral tube-feet are arranged in four crowded rows. The colour varies from very pale salmon-pink to deep vermilion.

Hab. On rocks from low-water mark to 10 or 12 fathoms. Wellington Harbour, and Taylor's Mistake (Te Onepoto) near Lyttelton. Type specimens are in the Canterbury Museum, Christchurch.

When a good series of this species—such as I have figured on Plates X., XI., and XII.—is carefully examined the most remarkable and peculiarly-interesting feature is seen to be, not so much the irregularity of the rays—which is, however, sufficiently striking—but, if I may use the expression, the regularity of the irregularity. A large number of specimens, especially the smaller ones, are seen to have the three adjacent rays on one side of the disc smaller and less developed than those on the other side, and the part of the disc to which the group of smaller rays is attached is less developed than the other part, and separated from it by a distinct depression, showing clearly that the specimens have undergone transverse division. The normal fully-grown forms have each six rays, four madreporiform plates, an elliptical disc, and a sulcus running across the narrower part of the disc. I have figured on Plates X., XI., and XII. the whole series collected by me during the summer of 1893–94, and, although a little dredging in deep water would perhaps produce some larger specimens, I have no doubt that they are fairly representative of the species. The madreporiform plates of each specimen are shown, and the sulcus, which marks the place of division, is indicated by a broken line. The figures are reduced to half the natural size. Of the sixty-seven specimens figured, fifty-five have six rays each; fifty-three of these show clearly that they have suffered division by the arrangement of the rays in two groups, the position of the madreporiform plates, and the sulcus across the disc. Of the rest, four specimens—Pl. X., figs. 5, 10, 23, and 28—have seven rays each. These are evidently abnormal forms, which have either divided unequally (figs. 10 and 28), or four rays have grown in the place of three (figs. 5 and 22). Four specimens—Pl. X., figs. 17 and 31; Pl. XI., fig. 3; and Pl. XII, fig. 7—have only five rays each, one of which—Pl. XI., fig. 3—was probably always a five-rayed individual, and shows no sign of division; but the other three show clearly that they have undergone division: they were probably six-rayed forms when young, but after division only two rays were developed in the place of the three. Only one specimen of the whole series, which is a five-rayed individual, has a madreporiform plate adjacent to the sulcus which marks the place of division (Pl. XII., fig. 7), but evidently the sixth ray, had it been developed, would have intervened here. Three specimens—Pl. X., fig. 25, and Pl. XII., figs. 13 and 14—have only three rays each. These had evidently divided shortly before they were collected, and the other rays had not begun to grow. Two of these—Pl. XII., figs. 13 and 14—are especially interesting. I found them close together. The rays of both are equally developed, and are the same size, shape, and depth of colour. They are, I have no doubt, the parts of a six-rayed

individual which had divided probably but a few hours before I found them. The wounds had not cicatrized, and the unsupported edges of the half-discs had not curved downwards, as they always do soon after division takes place. This curving-downwards of the unsupported margin forms the sulcus, which is not obliterated even when the regenerated parts of the disc and rays are fully developed. There are only three of the whole series which do not show clearly that they have suffered division (Pl. XI., figs. 1, 2, and 3). Fig. 32, Pl. X., is the smallest specimen of the series, and the only one not collected by me in the Wellington Harbour. It was found by Mr. Cecil Howard at Taylor's Mistake (Te Onepoto), near Lyttelton, and shows that division sometimes takes place in very young individuals. The small specimens figured on the upper part of Pl. X. were collected at low water in the early spring, when no large ones were to be found; later on during the summer I collected the larger specimens figured on the lower part of Pl. X, and those figured on Pl. XI., and in the autumn I obtained the largest specimens only, which are figured on Pl. XII. The following winter I again searched for specimens at Point Jerningham (Omarukaikuru), and High-water Islet, in Evans Bay, where I had found them in abundance during the summer, but, after a long and careful search, I only found a few young specimens under stones. Three of these, however, are especially interesting and peculiar forms (Pl. XII., figs. 12, 13, and 14). Only one specimen was obtained from deep water—Pl. XII., fig. 6—which I dredged up from about 12 fathoms, in the spring-time, when only small ones could be found at low water.

This species is evidently the southern representative of the North-Atlantic form, *Stichaster albulus* (*Asterias problema*), in which division also takes place. In a most interesting and instructive paper, published in the Ann. and Mag. Nat. Hist., ser. 4, vol. xii., p. 323, Dr. Lütken has shown that natural division is characteristic of a number of Echinoderms. His statements, however, appear to have been received with a good deal of doubt by naturalists generally. A careful examination of the series of specimens figured with this paper would, I have no doubt, convince the most incredulous that a natural spontaneous division does take place here, which is probably repeated several times, perhaps periodically, during the life of each individual. Professor Jeffrey Bell has described an exceedingly interesting asterid from Macclesfield Bank, *Patiria briareus* (Proc. Zool. Soc., 1894, p. 404), of which division is probably a characteristic. Five of the six specimens collected have each a group of short rays on one side of the disc and a group of longer ones on the other side. Thus Dr. Lütken's observations are confirmed.

Stichaster littoralis, sp. n. Plate XIII., fig. 2.

Rays 5. R = 32mm.; r = 12mm. Breadth of a ray near the base, 12mm.

Form stellate. Rays short, thick, rigid, broad at the base and tapering evenly to a rounded blunt extremity; dorsal surface rounded, with a well-defined, acute margin; ventral surface flat. The disc is slightly convex, with ten large primary apical plates, forming a circle round the centre of the disc, and a few smaller plates within them. The madreporiform plate is situated nearer the centre than the edge of the disc. It is small, and surrounded by an irregular wreath of spinelets. The plates on the rays form regular longitudinal series. They consist of a dorsal median series of large, broad, rounded, laterally peaked plates, with two series of small intermediate plates on either side; these are succeeded by a series of very large, broad, lateral plates. Then follows a series of marginal plates somewhat smaller than those of the median series, and sometimes a series of exceedingly small intermediate plates. The abactinal and lateral plates are armed with very short, robust, clavate, subequal spinelets, with rounded, granular summits. On the plates of the median series there is an irregular curved or angular line of spinelets, sometimes double, and sometimes with one or two spinelets within the angle. The plates of the two abactinal intermediate series bear each one spinelet (rarely two). On the lateral series of large, broad plates there is usually but one spinelet on the dorsal (superior) margin of each plate, and sometimes on the apical part of the ray there are two small spinelets on each plate, one above and the other below. The marginal plates bear one or two (usually two) short, stout, blunt, clavate spinelets, longer than those on the abactinal plates, forming an oblique line on the margin of the ray. The abactinal and lateral plates are covered with thick skin, on which are situated very small, scattered, sessile, forcipiform pedicellariæ, which are slightly larger and more numerous on the actinal side of the marginal plates and on the adambulacral plates. The papular areas are in regular longitudinal series, between the angles of the plates, with from 7 to 18 papulæ in each. The adambulacral plates are small, and so crowded that the spines are crushed into two rows, though the plates bear but one spine each. The spines are short and cylindrical. The ambulacral furrows are broad, and the tube-feet arranged in four rows. The dorsal surface is dark-brownish, or bluish-grey, with white or yellowish spinelets; and the ventral surface white or pale-yellow. Spirit specimens are light-brown.

I received a fine series of twenty-one specimens of this species from Mr. Cecil Howard, of Christchurch. They were

collected by him at Taylor's Mistake (Te Onepoto), a small, open bay near Lyttelton, where they are not by any means uncommon. They are not easily found, however, but need to be carefully searched for at low water, as they hide themselves away between large boulders, or in the crevices and under the projecting ledges of rock, and their colour corresponds well with the dark-grey rock on which they live. Collected by Mr. H. B. Kirk at Stewart Island.

Type specimens are in the Canterbury Museum, Christchurch.

Tarsaster neozelanicus, sp. n. Plate XII., figs. 15–23.

Rays 8, sometimes 7. R = 36mm.; r = 5mm. Breadth of a ray near the base, 4mm. or 5mm.

Disc small, usually ovate, rather convex. Rays narrow, elongate, well rounded above, almost cylindrical, tapering very gradually from the base to the extremity. Interbrachial arcs acute. Madreporiform plates very small, usually numerous—3 or 4—situated nearer the edge of the disc than the centre, surrounded by a wreath of spinelets. The plates on the rays consist of a dorsal median series of rather large plates, followed on either side by a series of intermediate plates about the same size as those of the median series; there are sometimes two series of intermediate plates on the basal part of the ray. These are suceeeded by a series of very large, broad, lateral plates. Between these lateral plates and the adambulacral plates there is a single series of rather large marginal plates, and sometimes a series of very small intermediate plates, on the basal part of the ray, between the marginal plates and the adambulacral plates. The armature of the abactinal and lateral plates consists of exceedingly small, short, obtuse, subequal spinelets with granular summits. On the plates of the median series there is either an irregular group or an acutely angular line of from 3 to 8 spinelets, usually with a larger one situated in the middle. On the intermediate plates there is a group of 2 or 3 spinelets. On the large lateral plates there is a group or an oblique line of 3 or 4 spinelets on the abactinal part of each plate and one or two spinelets on the actinal margin. The plates of the marginal series are armed with 2 or 3 rather long, blunt, cylindrical or slightly oar-shaped spinelets, which form an oblique line. The adambulacral plates bear two blunt, cylindrical spinelets, which form two regular divergent rows along the edge of the ambulacral furrow. There is usually but one large papula (sometimes a large one and a small one) to each papular area; the pores are large, arranged in regular longitudinal rows. The pedicellariæ on the abactinal and lateral surfaces are very numerous, scattered, rather large, sessile,

forcipiform, and well spaced. There are one or two larger ones on each adambulacral plate within the furrow, and groups of these larger ones on the plates which form the mouth-angle. The tube-feet are in four rather crowded rows. The colour in life is dark-grey above, sometimes variegated with brown, and white beneath.

Hab. On the roots of *Lessonia*, Ohiro Bay and Lyall Bay. Type specimens are in the Canterbury Museum, Christchurch.

I have given outline figures of a few specimens (Pl. XII., figs. 15 to 23), which are reduced to half the natural size: from these it will be seen that the rays are very irregular in size, especially in young individuals, and, as in *Stichaster insignis*, they usually form two groups—a group of small rays on one side of the disc and a group of larger ones on the opposite side. This seems to indicate that natural division (fission), which is a characteristic of *S. insignis*, also obtains in this species. My series of specimens is, however, very small at present, but the species is not uncommon near Wellington, and I hope to collect more specimens shortly, so as to be able to settle definitely this interesting point.

Art. XXI.—*Descriptions of Two New Gymnoblastic Hydroids.*

By H. Farquhar.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

Plate XIII. (in Part).

Coryne tenella, n. sp. Plate XIII., fig. 5.

Hydrocaulus simple or sparingly branched, slender, lax, pale horn-colour, attaining a height of about 15mm., arising from a creeping filiform stolon. The stems are smooth except at the base, where there are a few annulations, and the branches are sometimes slightly corrugated immediately above their origin. Hydranths elongate, cylindrical, sometimes slightly clavate, pellucid-white, with frequently a yellowish-brown tinge. Tentacles pellucid-white, with small spherical knobs, twenty-five to thirty in number, a verticil of four or five round the mouth, and another lower down; the rest scattered and frequently crowded on the lower part of the hydranth, sometimes with an indistinct tendency to a verticillate arrangement. Gonophores oval, sessile, in a cluster of three to five on the lower part of the hydranth among the tentacles.

Hab. Wellington Harbour. On the roots and stems of *Macrocystis pyrifera*. Type specimens in the Canterbury Museum, Christchurch.

Tubiclava rubra, n. sp. Plate XIII., fig. 6.

Hydrocaulus slender, lax, sparingly branched, attaining a height of about 12mm., arising from a creeping filiform stolon. Hydranths fusiform, very contractile, deep vermilion. Tentacles somewhat scattered, forming three irregular verticils, the lower ones rather smaller than the others, pellucid-white, contractile. Perisarc smooth or slightly annulated below, colourless and transparent, usually invested by minute plants and animals. The cœnosarc in the stems and stolon is of a light-reddish colour. Gonophores sessile, red, developed on separate stems, three or four on the summit of a stem.

Hab. Wellington Harbour. Abundant on the roots and stems of *Macrocystis pyrifera*. Type specimens in the Canterbury Museum, Christchurch.

Very few New Zealand gymnoblastic hydroids have been described. I know of only three other species—viz., *Tubularia attenoides*, Coughtrey (Trans. N.Z. Inst., vol. viii., p. 302, 1875), from Dunedin; *Eudendrium novæ-zelandiæ*, Marktanner-Turneretscher (Annal. d. k.-k. Naturhist. Hofmuseums, band v., p. 201, 1890), from Auckland; and a species of the freshwater genus *Cordylophora* found by Mr. A. Hamilton in the Esk River, near Napier (N.Z. Journal of Science, vol. i., p. 419, 1883), which Mr. Hamilton doubtfully identified as the European form *C. lacustris*, quoting Professor Allman's description of the genus. It is more likely to be identical with the Australian species, *C. whiteleggii*, v. Lendenfeld (Zool. Jahrbücher, bd. ii., p. 97, 1886). When rediscovered, however, it will probably prove to be distinct from both the European and Australian forms.

The fact that so few species have been recorded does not by any means indicate that our hydroid fauna is poor and deficient in this group, but only that they have been neglected by New Zealand naturalists. Mr. H. B. Kirk informs me that he has found a species at Kau Bay, on the south side of the Wellington Harbour, perhaps the *Coryne* described above. I have myself collected specimens of a very beautiful *Tubularia* on the roots of *Lessonia*, at Ohiro Bay, near Wellington, which I believe is distinct from Dr. Coughtrey's species, and I have seen the polypidoms of several other species. No doubt a careful and systematic search would reveal many new and interesting forms.

Art. XXII.—*Notes on some Crustacea from Macquarie Island.*

By George M. Thomson, F.L.S.

[*Read before the Otago Institute, 13th November, 1894.*]

Plate XIV.

After his return from his eventful trip to Macquarie Island, in May of the present year, the small collection of Crustacea made on the island by Mr. A. Hamilton was handed to me by Professor Parker for examination. This consisted of two or three bottles containing littoral species, one small bottle of fresh-water specimens, and portion of the claw of a large crab which I have not been able to identify. The chief interest naturally attaches to the fresh-water fauna. Mr. Hamilton's collection included only several specimens of a small *Chydorus*, which is apparently identical with the New Zealand *C. minutus*, mihi, and two imperfectly preserved female specimens of a Copepod belonging to the *Calanidæ*, and for which I propose to provisionally form the new genus *Guernea*. The only member of this family hitherto described from New Zealand is *Boeckella* (*Boeckia*) *triarticulata*, mihi, from which this species is very distinct.

Order DECAPODA.

Tribe Brachyura.

1. **Halicarcinus planatus**, Fabr.

Three female specimens, all more or less mutilated, occurred in the collection. This species is very common, and is widely distributed throughout the whole of the antarctic and south Australasian region.

Order ISOPODA.

Family Sphæromidæ.

2. **Sphæroma gigas**, Leach.

This well-marked species was numerously represented. It is abundant throughout the antarctic region.

Family Asellidæ.

3. **Iais pubescens**, Dana. (For the synonymy of this species see Trans. N.Z. Inst., vol. xxiv., p. 266.)

This species was originally found by Dana in Nassau Bay, Tierra del Fuego, as a parasite or commensalist on *Sphæroma lanceolata*. It has been found along with *S. gigas* at Ker-

guelen Island, with *S. obtusa* in various parts of New Zealand. and I found it among specimens of *S. quoyana* from Tasmania,

Order AMPHIPODA.

Family Orchestidæ.

4. **Hyale novæ-zealandiæ.**

Nicea novæ-zealandiæ, G. M. Thomson, Trans. N.Z. Inst., vol. xi., p. 235, pl. 10, figs. B1, *a–f*.

Nicea neo-zealanica, Thoms. and Chilton, Trans. N.Z. Inst., vol. xviii., p. 144.

I have not met with this species since describing the original specimens in 1878. These were obtained in the neighbourhood of Dunedin. Mr. Hamilton's collection from Macquarie Island contained four specimens, all females.

5. **Hyale fimbriata.**

Nicea fimbriata, G. M. Thomson, Trans. N.Z. Inst., vol. xi., p. 236, pl. 10, figs. B2, *a–e*.

This species, like the last, was originally described in 1878, from specimens found near Dunedin. Numerous specimens occurred in the present collection. The degree of fimbriation of the second antennæ, the character from which the specific name is derived, varies a good deal in different individuals.

Family Atylidæ.

6. **Atyloides australis,** Miers.

Several specimens of this species occurred in the collection. It has only hitherto been found in Kerguelen Island, but is allied to, if not identical with, *A. megalophthalmus*, Haswell, an Australian species.

Order BRANCHIOPODA.

Tribe Cladocera.

7. **Chydorus minutus,** G. M. Thomson, Trans. N.Z. Inst., vol. xi., p. 262, pl. 11, fig. E3.

Numerous specimens of a very small *Chydorus*, which I think are not specifically distinct from the New Zealand *C. minutus*, mihi, were found by Mr. Hamilton in a fresh-water pool. They were dark-brownish in colour, probably due to the peaty nature of the soil in which the pools occur.

The occurrence of the same minute fresh-water species in New Zealand and in such a distant and isolated land as Macquarie Island is not very easily capable of explanation. Certain species of gulls, which have no doubt great powers of flight, and which, both in New Zealand and in the Macquarie Island, nest in inland localities, could transport mud on their feet, and

could thus carry the eggs of these small crustaceans to distant places; but gulls seldom fly for any great length of time without lighting on the surface of the sea, and the chances of their being able to reach such an outlying spot with living eggs of a species like *Chydorus* are very small. Along with the crustacean was a solitary and minute Hydrachnid, which, however, in absence of knowledge of the Australasian *Hydrachnida*, has not been identified as yet.

Order COPEPODA.

Family Calanidæ.

Among the material of the sponge taken from a fresh-water pool were two specimens very imperfectly preserved of a species of Copepod belonging to the *Calanidæ*. Unfortunately, even with all possible care in dissecting, the bodies were in such a soft and disintegrated condition that I could not accurately separate and distinguish the legs. From the position in which the specimens were obtained it seemed to me probable that they lived in cavities in the sponge, and this might partly account for the soft condition of their bodies. While the mouth-parts were, on the whole, similar to those of *Calanus* and allied genera, the fifth pair of legs seemed quite distinct from anything I have met with before. The chances of getting material collected representing the fresh-water fauna of these antarctic islands are so few and far between that, even with the imperfect data in my possession, I have thought it desirable to provisionally describe the present form.

Genus **Guernea**,* nov. gen.

Female.—Cephalothorax six-jointed (?). Anterior antennæ 25-jointed. Posterior antennæ two-branched, the secondary branch, as in *Calanus*, having four small intercalated joints. Mandibles with a wide and strong cutting-edge, and a two-branched palp, branches respectively two- and four-jointed, setose. Maxillæ plate-like, with two lobed processes fringed with marginal setæ. Anterior foot-jaws strong, with numerous long setæ on the terminal joint. Posterior foot-jaws five-jointed, the three last joints each bearing a seta. Legs not clearly made out. Third (?) pair with both branches two-jointed. Fourth (?) pair with outer branch two-jointed, inner branch one-jointed. Fifth pair with both branches one-jointed, consisting each of a single plate. Abdomen four-jointed (?); caudal setæ short.

* After M. Jules de Guerne, Vice-President de la Société Zoologique de France, and joint author with M. Jules Richard of the "Révision des Calanides d'Eau douce."

8. **Guernea antarctica**, nov. sp. Plate XIV.

Length of body, exclusive of the caudal setæ, about 1·45mm.

Anterior antennæ less than half as long as the body, 25-jointed, joints furnished with one, or rarely two, very short setæ. Posterior antennæ about one-third as long as the anterior pair; with one branch two-jointed, joints subequal in length, and the terminal one bearing at its apex about five slender setæ; secondary branch seven-jointed, the last joint bearing three slender setæ at its apex, and about as long as the four preceding joints, each of which bears a single seta.

Mandibles with a straight cutting-edge, furnished with nine (or ten) small even teeth; palp two-branched; base two-jointed, the proximal joint broadening upwards and bearing four setæ on its outer edge; outer branch two-jointed, proximal joint broader than long, with three setæ on its outer edge, distal joint short with four terminal setæ; inner branch four-jointed, distal joint broad, ending in three or four long setæ, next three joints short, subequal, the terminal ending in three setæ.

Foot-jaws as in *Calanus*.

In the fifth pair of legs each branch is one-jointed, the outer plate having two short spines on its outer edge, three at its apex, of which the inner is the longest and strongest, and two short slender ones on its inner edge; the inner branch is not half as long as the outer, and bears a few very short spines on its margins.

The abdomen is only about one-third as long as the rest of the body.

The caudal segments are about equal in length to the preceding segment, and are twice as long as broad. Each bears four terminal setæ, of which the inner three are about as long as the abdomen, and the outer is barely half as long, while on each margin near the extremity is a short seta.

Family Peltidiidæ.

9. **Zaus contractus**, G. M. Thomson, Trans. N. Z. Inst., vol. xv., p. 106, pl. 10, figs. 1–7.

Two male specimens of this or a closely-allied Copepod occurred in the collection. They differed from the type species in the following details: The body was somewhat longer than in the New Zealand form, and, as seen from the side, was somewhat tumid. The central caudal seta on each side was two-thirds as long as the body, whereas in my original figures they appear rather short; but I think this was probably due to their being broken. While the second and fourth pairs of feet bore on their outer branch the four pectinated spines which

are so characteristic of this genus, the third pair appeared to have in their place four strong, straight, and smooth spines. The foot of the fifth pair was also different, the inner branch bearing several short spinose teeth, the outer lobe, which is hardly produced at all, bearing a single slender short seta.

If this should prove to be a new species, I would name it *Z. hamiltoni*, after the enthusiastic naturalist who has done so much to add to our knowledge of Macquarie Island.

EXPLANATION OF PLATE XIV.

Figs. 1–8. *Guernea antarctica.* Fig. 1 × 56; figs. 2–8 × 184.

Fig. 1. Body as seen from the side.
Fig. 2. Anterior antenna.
Fig. 3. Posterior antenna.
Fig. 4. Mandible.
Fig. 5. Maxilla.
Fig. 6. Anterior foot-jaw.
Fig. 7. Foot of fifth pair.
Fig. 8. Caudal segments and setæ.

Art. XXIII.—*On the most frequent Pelagic Copepods and Cladoceres of the Hauraki Gulf.*

By Dr. Augustin Krämer, Physician H.I.M.S. "Bussard."

[*Read before the Auckland Institute, 1st October, 1894.*]

Plates XV.–XXIII.

During a stay of about four months at Auckland, from November, 1893, till February, 1894, I was able to get much "plankton" from very different parts of the Waitemata Harbour (except the interior part, beyond the Sentinel Rock), and of the Hauraki Gulf, between Tiritiri, Great Barrier Island, and Rangitoto.

By the measure of more than fifty perpendicular draughts with a volumetric plankton-net I found that the small crustacea, Copepods and Cladoceres, are abundant on every spot, together with many kinds of Diatomaceæ (*Coscinodiscus, Bidulphia, Chætoceros, Triceratium, Ceratium,* &c.). There are also always present a genus of Radiolaria, some Appendiculariæ, and Rotifera. As far as it is possible to work out the material on board a ship in a short time I believe that I have done it; but naturally this treatise can be no definite one: but, as

almost nothing has yet been published on the pelagic Copepods and Cladoceres, I will not delay giving a report.

What is known of the Copepods of New Zealand is contained in a treatise by G. M. Thomson, of Dunedin, published in vol. xv. of the Transactions; but, because his collections are "from rock-pools or shore-kelp" of the Otago Harbour, they include little beside the Harpacticidæ, which, with a few exceptions, belong to the littoral and not to the pelagic fauna.

The word "plankton" is now commonly adopted for "pelagic moulder," or "auftrieb." It means the small (microscopical) organisms floating in the sea or in a lake; and "pelagic plankton" would mean those floating free from the coast and from the bottom. The Copepods, these small crustaceans, are the most important, and never-wanting, part of the plankton.

On the volumetric draughts I shall report later, when the material is worked out. It is found that the plankton contains more species and much more individuals in the Hauraki Gulf (and in Waitemata Harbour) than in the open sea, as, for instance, outside Great Barrier Island.

Dana, in the publications of the United States Exploring Expedition, has named only four Copepods as found in the neighbourhood of New Zealand. Giesbrecht, in his excellent work on the Copepods ("Fauna und Flora des Golfes von Neapel," vol. xix.), which is also the newest and most fundamental one, including all that was known about the order up to 1892, says, on these four species, that the names of three must be changed, following the priority of authorship.

1. *Pontella valida*, Dana, is not a *Pontella;* but the genus cannot be recognized from Dana's description.

2. *Pontellina simplex*, Dana, is not a *Pontellina*, but a *Labidocera*.

3. *Miracia gracilis*, Dana, is now commonly known as *Setella gracilis*, Dana.

The fourth, *Saphirina gemma*, Dana, retains the name given by Dana. *Setella* (*Miracia*) and *Saphirina* seem to belong principally to the open sea. I found *Setella* near the Kermadec Islands, but never in the harbour. A *Pontella* has recently been found by Thomson in the Otago Harbour, and one species of *Labidocera* in the Hauraki Gulf.

Of all the Copepods recorded from the Pacific Ocean anywhere near New Zealand, I have only found two in the Hauraki Gulf—the widespread and common *Paracalanus parvus*, Claus, and *Clausocalanus arcuicornis*, Dana. *Euterpe acutifrons*, Dana, which is invariably present in the gulf, in the Pacific has only been found in long. 108° W. and lat. 20° S., near Easter Island. All the other Copepods named below are quite new for the Pacific, and therefore also

for New Zealand; and also the Cladoceres, as far as I know.

The result of this treatise is: Altogether, twelve Copepods and four Cladoceres are found in the Hauraki Gulf, only three of which (as named above) are known from other reports for New Zealand. One genus and three species of the Copepods and three species of the Cladoceres are quite new. As to the treatise of G. M. Thomson, none of the Copepods described there have been found in the Hauraki Gulf—a proof that there is much to do still in this direction, principally with regard to the littoral fauna.

For comparison, in the very well searched harbour of Kiel, in Germany, twenty-six Copepods have been collected, of which fourteen are Harpacticidæ, all belonging to the littoral fauna; and in the sea near Naples altogether 125 (five-twelfths of all known free Copepods). It is very interesting that, of the 129 Copepods belonging to the Mediterranean, twenty-seven have never been found in the Atlantic, but only in the Pacific Ocean.

The following is a catalogue of the species which I have collected. The classification is that of Giesbrecht:—

I. Copepoda.

1. Fam. Calanidæ.
   (1.) Paracalanus parvus, *Claus.*
   (2.) Clausocalanus arcuicornis, *Dana.*

2. Fam. Centropagidæ.
   (3.) Centropages typicus, *Krüyer*, var. aucklandicus.
   (4.) Temora turbinata, *Dana.*
   (5.) Leuckartia, *sp.* (?).

3. Fam. Pontellidæ.
   (6.) Labidocera cervi, *n. sp.* ♀.
   (7.) Acartia clausii, *Giesbr.*

4. Fam. Cyclopidæ.
   (8.) Oithona nana, *Giesbr.*

5. Fam. Harpacticidæ.
   (9.) Euterpe acutifrons, *Dana.*

6. Fam. Oncæidæ.
   (10.) Oncæola specialis, *n.g. et sp.*

7. Fam. Corycæidæ.
   (11.) Corycæus tenuis, ♀, *Giesbr.*
   (12.) Corycæus aucklandicus, *n. sp.*

I have not thought it necessary to give descriptions of the known species, for they are fully described in the work of Giesbrecht, and of the new genus and species I mention only the differential characters, giving references to the plates. The figures have been exactly executed with a drawing apparatus.

I. COPEPODA.

1. Fam. CALANIDÆ.

1. **Paracalanus parvus,** Claus.

Is known from several places in the Pacific, but has not been previously obtained from the immediate neighbourhood of New Zealand. In the Waitemata Harbour a few specimens only have been found, but it is very frequent in the Hauraki Gulf, especially in the Tofino Bay, where it was of a dark-red colour.

2. **Clausocalanus arcuicornis,** Dana.

Was found by Dana in lat. 32° S. and long. 178° E., near the Kermadec Islands, and by Giesbrecht in the more northern parts of the Pacific, in the depth of 4,000m. (13,000ft.). In the Hauraki Gulf a few female specimens were found near the Island of Motuhurakia. The proportions of the segments of the first antenna are nearly accurately the same as Giesbrecht mentions. The teeth of the inner margin of the basalia 2 of the pes II. and III. are conspicuous. Total length, 1·25mm.

2. Fam. CENTROPAGIDÆ.

3. **Centropages typicus,** Kröyer, var. **aucklandicus.** Plate XV., figs. 1–5.

The species has not been previously found in the Southern Hemisphere, but the nearly-related *C. brachiatus*, Dana, is recorded from the Cape of Good Hope and from the west coast of South America. Found in the Hauraki Gulf, but not generally distributed (♂ and ♀).

The hooks of the fifth segment of the thorax (fig. 5) like spines; anal segment of the male not reduced, nearly as long as the preceding. Seta externa of the furca ♂, which is twice as long as broad, not near the margin of the end.

Genital segment (1) of the female not armed with four setæ; the following segment (2) a little longer than this, and without a knob.

Fifteenth joint of the first antenna ♂ also with a big spine similarly to the sixteenth joint (like *C. brachiatus*).

Fifth foot ♂ (fig. 1). Inner branch of the hand (tongs) not so strong and short, but as long and thin as the outer.

Fifth foot ♀ (fig. 2). Thorn inside of the second joint of the ramus externus (*R.e.*) not longer than the joint itself (as long), and not standing off and not so strong.

Fourth foot. Spine outside of the second joint of the ramus externus dexter just as in *C. typicus*, Kröyer, but the end is blunt.

There are many slight differences between this variety and the old form; but it does not seem necessary to form a new species, as the general similarity is great. I have therefore distinguished it as *var. aucklandicus*.

4. **Temora turbinata,** Dana.

Described by Dana from the Sulu Sea, and by Giesbrecht from Hongkong and Amoy. Is very common in all parts of the harbour and gulf in all states of development, the young having a red wing on each side of the body.

5. **Leuckartia,** Claus, sp. (?).

Only one specimen found in the gulf. Was recognized as a *Leuckartia* for certain, but, as the species would be a new one, and there is the possibility that the specimen was juvenile, I only notice the presence of this genus for further examinations.

3. Fam. Pontellidæ.

6. **Labidocera cervi,** n. sp. ♀. Plate XVI., figs. 6 and 7.

I only found one specimen, a female, in the Hauraki Gulf. The species is a new one, and belongs to the group of *L. orsinii*, *nerii*, and *pavo*. Length of the thorax, 2·3mm.; of the abdomen and furca, $\frac{1}{3}$mm. The appearance is like that of *L. nerii*. (1mm. = $\frac{1}{25}$in.)

Head without a crista, but with a long rostrum (as long as the first joint of the first antenna, fig. 6).

Antenna I. as *L. brunescens* (Giesbr., tafel 23, fig. 7).

Antenna II. as *L. kröyeri* (Giesbr., tafel 23, fig. 23).

The ramus internus is shorter, with four long and one short setæ on the end. Mandible, maxilla, maxillipeds, like *L. wollastoni*.

The last joints of the four swimming-feet are armed as follows:—

		Pes I.	Pes II.	Pes III.	Pes IV.
Ramus externus, third segment	Outside thorns ..	2	3	3	3
	Inside setæ ..	4	5	5	5
Ramus internus, second segment	Setæ	6	8	8	7

The most characteristic part is pes V. and the two-segmented abdomen. Pes V. (fig. 7) is a little similar to that of *L. pavo*, but the hooks are stronger, like the horn of a stag of ten antlers.

The rami externi of the fifth feet of the four species are characterized as follow:—

	On the End.	On the Outside Margin.
L. orsinii ..	1 point.	..
L. nerii ..	3 points of middling size.	..
L. pavo ..	3 points of middling size.	2 small points.
L. cervi, n. sp. ..	3 large points.	2 large points.

The abdomen is nearly the same as that of *L. nerii* and *orsinii*, but the fifth foot of these two is very different. On the contrary, the fifth foot is a little like that of *L. pavo*, but of this the abdomen is very different. Therefore it seems to be necessary to form a new species.

I have only found one female. There is also the female only of *L. orsinii* and *pavo*, Giesbrecht, known from the Red Sea. *L. nerii* ♂ and ♀ has been found in the Pacific, near the equator, like most other species of *Labidocerœ*.

7. **Acartia clausii**, Giesbr.

Has previously only been found in the Northern Hemisphere. It is always present in the harbour and gulf.

4. Fam. CYCLOPIDÆ.

8. **Oithona nana**, Giesbr. Plate XVII., figs. 1–9.

Very common throughout the harbour. It is peculiar that this species has only recently been found by Giesbrecht at Naples, and not elsewhere.

Setæ terminales of the furca feathered (fig. 1), and, as well as the end of the abdomen, of a dark-red colour, reminding one of the same parts of the related *Thorellia brunnea*, Boeck, var. *antarctica*, found by Thomson in the Otago Harbour (vol. xv., p. 95, pl. v., fig. 19).

Oithona similis, Claus, seems also to be present in the harbour, or perhaps some other species; but time did not allow me to identify all the specimens.

5. Fam. HARPACTICIDÆ.

9. **Euterpe acutifrons**, Dana.

Has already been found in the Pacific, near Easter Island, as mentioned before. This Harpacticid is one of the few pelagic ones very common in all parts of the harbour and gulf, males and females.

6. Fam. ONCÆIDÆ.

Oncæola, nov. gen.

Appearance *Cyclops*-like, and therefore like *Oncœa*.

Antenna I. 6-jointed.

Antennna II. 4-jointed.

First and second maxillipeds different.

The principal difference is that the ramus internus of the fourth foot is not nearly as long as the ramus externus, but much smaller, and of the same form and size as the fifth foot, which is a staff of middling size and armed with two setæ on the end.

Only found a few female specimens in the Waitemata Harbour.

10. **Oncæola specialis**, n. sp. Plates XVIII., and XIX., figs. 1–9.

Size, 0·8mm.; thorax, 0·5mm.; abdomen and furca, 0·3mm.

Antenna I. 6-jointed (fig. 2), fourth joint scarcely longer than the following. No æsthetasks.

Antenna II. 4-jointed (fig. 3).

Maxilliped I. (fig. 4) like a cock's comb.

Maxilliped II. (fig. 5) both not of equal size.

Swimming-feet I., II., III. (fig. 6) all equal.

Seta interna of the second joint of the ramus externus and of the first joint of the ramus internus much stronger in the proximal part than on the end.

The third joint of the ramus externus of foot III. has, as in foot IV., three thorns, and is only about as long as the first and second joints together.

Swimming-foot IV. (fig. 7a). Ramus internus staff-like, 2-jointed ; first joint small, second joint long, with two setæ on the end.

Foot V. (fig. 8). A one-jointed staff, with two setæ on the end, just as the ramus internus of the fourth foot.

Abdomen 5-jointed, the first segment bearing the fifth foot-pair. Second genital segment as long as the three following, the form like a pear, with a knob and three small spines upon it (fig. 8). Furca (fig. 9) a little longer than the preceding anal (fifth) segment of the abdomen.

7. Fam. Corycæidæ.

11. **Corycæus tenuis**, Giesbr. ♀.

Only one female specimen found in the Hauraki Gulf. The species has only been previously described by Giesbrecht from the west coast of Central America, and also a female only. My specimen was recognized without doubt as *C. tenuis*, and it is to be hoped that the male will also be discovered in New Zealand. I was led to search specially for this species because the following new species (*C. aucklandicus*), which is very common in the harbour, is very nearly related to it; and I am glad to say that in this search I was at length successful.

12. **Corycæus aucklandicus**, n. sp. Plate XX., figs. 1–10.

I named it *aucklandicus* because this Copepod seems to be a very steady and common inhabitant of the Auckland waters; males and females frequent.

Total length, 1·2mm.

The new species belongs to the group *C. lubbockii* and *tenuis*, which are distinguished from the other *Corycæi* by the reduced ramus internus of the fourth swimming-foot.

Antenna I. 8-jointed.

Antenna II. (fig. 4, ♂ ; fig. 6, ♀) } Claws of particular form,
Maxilliped II. (fig. 5, ♂ ; fig. 7, ♀) } as the figures show.

Swimming-feet I., II., III. (pes I., fig. 8; pes III., fig. 9). Ramus externus and internus of every foot 3-jointed.

Swimming-foot IV. (fig. 10). Ramus externus 3-jointed. Ramus internus reduced, small, with two long setæ.

The abdomen is 2-jointed (fig. 2, ♂ ; fig. 3, ♀). The first genital segment bears one long and one very short seta. The second anal segment is smaller than the first. The male bears on the under-margin of the first segment a small hook (fig. 2), as in *C. obtusus*, which it resembles altogether much more than the female of the new species resembles the female of *C. obtusus*.

The proportions of abdomen and furca are as follow:—

	(1.) Genital Segment.	(2.) Anal Segment.	Furca.
C. lubockii, ♀	9	4	11
C. tenuis, ♀	7	4	8
C. aucklandicus, ♀	7·5	4	5
„ ♂	14	5	8

II. CLADOCERES.

I little hoped when I began my examination of Auckland Harbour to find so many kinds of Cladoceres—three of the four genera belonging to the saltwater: *Podon*, *Evadne*, *Penilia*, missing only *Bosmina*. Three of the four species are new. They are as follow:—

1. Fam. Podontidæ.
   (1.) Podon polyphemoides, *Leuckart.*
   (2.) Podon trisetosus, *n. sp.*
   (3.) Evadne aspinosa, *n. sp.*
2. Fam. Sididæ.
   (4.) Penilia pacifica, *n. sp.*

As before, I only give a short description, the figures showing best the differences.

1. Fam. PODONTIDÆ.

I. Podon, Lilljeborg.

Head straight, separated from the body by a small incision.

1. **Podon polyphemoides,** Leuckart. Plate XXI., figs. 1–5.

The species is frequent in the Baltic Sea, and is also abundant in the Hauraki Gulf. To distinguish the different species of *Podon* it is necessary to mark the setæ of the small ramus externus (appendix externus) of the four swimming-feet. A comparison of the old species and the new one shows as follows:—

Setæ of the ramus externus of		Pes I.	Pes II.	Pes III.	Pes IV.
	Podon leuckartii, Sars ..	1	1	1	2
	„ intermedius, Lillj. ..	2	1	1	2
	„ schödlerii, Czerni. ..	2	3	3	1
	„ *polyphemoides, Leuck.*	3	3	3	2
	„ *trisetosus, n. sp.* ..	3	3	3	3
	„ schmackeri, Poppe.	4	4	4	2

The new species is, as already named,

2. **Podon trisetosus,** n. sp. Plate XXI., figs. 6–8.

Every ramus externus is armed with three setæ. There is also a good mark of difference between the two Auckland species in the large antenna (figs. 2 and 8); for the setæ of the 4-jointed ramus are distributed as follows:—

Setæ of		P. polyph.	P. trisetosus.
	1st joint ..	0	0
	2nd joint ..	0	1
	3rd joint ..	2	1
	4th joint ..	4	4

P. trisetosus is very scarce in the harbour and gulf.

II. **Evadne,** Lovén.

Head depressed. Not separated from the body by an incision.

Only one species has been found; it is new. Having no spine like *Evadne spinosa,* which I afterwards found in Jervis Bay, near Sydney, together with this new species, I called it

3. **Evadne aspinosa,** n. sp. Plate XXII., figs. 1–8.

The body is round (fig. 1). The setæ of the ramus externus of the swimming-feet are 2, 3, 3, 1; the two setæ of the first appendix (fig. 6) are longer and stronger than the following. This bisetose appendix is a very good mark to distinguish this *Evadne* from *Podon* if the form of the body is not quite conspicuous, as sometimes occurs.

2. Fam. Sididæ.

Genus **Penilia,** Dana.

Dana described two species—*P. avirostris,* from Rio Janeiro, and *P. orientalis,* from the Sunda Strait. I give the details in the description of the species from Auckland.

4. **Penilia pacifica,** n. sp. Plate XXIII., figs. 1–5.

Thomson knew of the presence of a *Penilia* in the Bay of Islands. As I have found it first in the Auckland Harbour, and afterwards in Port Jackson (Sydney), it seems that this species is common in the southern Pacific, and therefore I gave the name *pacifica.* At first I found one specimen in the Waitemata Harbour; only in February in Tofino Bay, and in

the open gulf, there was a large number in all states of development. At times the number was so large that of ten organisms in the draught one was a *Penilia*. No males were found; they seem to live at another time. The females had nearly all some eggs or embryos (I saw once eight) in the brood-bag.

In the middle of the head, one eye surrounded with crystal lenses (fig. 3, *d*); one rostral spine on each side of the head (figs. 1, 2, 3). Behind the rostrum *the first antenna*, a small one-jointed palpus with some short setæ on the end (fig. 2) (one larger and some smaller). *The second antenna* (fig. 4) is long (the rowing-antenna) and two-branched; each branch is two-jointed. The ramus externus (*R.e.*) bears six setæ on the last (2) and two on the first segment. The ramus internus (*R.i.*), four and one. Each segment is armed with a small spine. Behind the eye is the heart (fig. 3, *c*), and between the eye and heart a secondary eye (*b*). On each side of the heart is a sucking-disc (*a*).

The integument of the body, the shell, covers six leaf-shaped feet (branchipods), and is slightly denticulated on the margin. The form of the shell in reference to the head and the abdomen is best seen in fig. 1, and described below in comparison with the species of Dana.

The length of the animal is about 1mm. ($\frac{1}{25}$in.).

The abdomen (fig. 5) is armed with two long stylets, each bearing two small thorns (a longer and a shorter one). The stylets are about as long as the abdomen. Two long setæ (about as long as the body) are placed on two appendages of the upper part of the abdomen.

The difference between the three species is,—

P. AVIROSTRIS.	P. ORIENTALIS.	P. PACIFICA.
Shell.		
Posteriorly over the middle of the back excavated; *anteriorly* forming an acute angle with the head.	*Posteriorly* shallow excavated; *anteriorly* forming no acute angle with the head.	*Posteriorly* a little excavated; *anteriorly* forming an acute angle with the head.
Setæ of the Dorsal Appendages of the Abdomen.		
Not so long as the caudal stylets, barely reaching to the base.	Long, reaching beyond the apex of the stylets.	Very long, reaching far beyond the apex of the stylets (as long as the body).
Palpus (Ant. I.).		
Present.	No palpus.	Present.

As I mentioned above, I also found *P. pacifica* in Port Jackson, and another new and distinct species in the crater-lake Lanuto'o, in Samoa, 2,000ft. above the level of the sea.

ART. XXIV.—*Notes on the Larger Species of* Paryphanta *in New Zealand, with some Remarks on the Distribution and Dispersal of Land-shells.*

By W. T. L. TRAVERS, F.L.S.

[*Read before the Wellington Philosophical Society, 22nd August, 1894.*]

I HAVE placed on the table this evening four specimens of the larger species of *Paryphanta* found in these Islands. The earliest of the species in order of discovery is *P. busbyi*, so named in honour of the late Mr. James Busby, the first Resident Agent of the Crown in New Zealand. The next is *P. hochstetteri*, so called by Pfeiffer who first examined it, after the late Professor Von Hochstetter, by whom the first specimen of this species was found near some ponds on the Dun Mountain Pass, between Nelson and the Pelorus Valley. Specimens of the third shell have been found in the Collingwood district, on Stephens Island at the western entrance to Cook Strait, and in the Manawatu and Waikanae districts, in this Island. This latter shell has not yet been authoritatively described, and I am informed by Professor Hutton that he and Mr. Suter have agreed, for the present at all events, in treating it as only a variety of *hochstetteri*, and so not entitled to a distinct name. It is provisionally called the dark *hochstetteri*, a name based upon the fact that in all the specimens hitherto obtained the inferior half of the shell is nearly black, whilst the superior surface resembles in colour and markings what I assume to be the typical *hochstetteri*, the inferior half of which is usually of the same colour as the superior one, and similarly marked. In treating this shell as a mere variety of *hochstetteri*, Hutton and Suter have no doubt taken into consideration a coincidence in the number and character of the whorls, and the close resemblance in the forms of the umbilicus, in the two shells. It may be, however, that further examination, and especially of the animal which inhabits it, will lead to its receiving specific distinction ; but this is matter for the future.

Specimens of the fourth shell have, so far as I personally know, only been obtained from the ranges of hills in the neighbourhood of Picton, but Sir James Hector tells me that he believes that specimens much resembling the Picton ones have been found in the Manawatu district. Singularly enough, the Picton shells are usually treated by collectors as representing the typical *hochstetteri* of Pfeiffer, whereas the drawing in Hochstetter's work on New Zealand, which is now before you, shows clearly enough that the shell found by him closely resembles the shell now exhibited from the Museum collection,

which was found by Sir James Hector near Waitapu, the boat-harbour of the Takaka Valley in Massacre Bay.

The distribution of these shells, so far as it is at present known, is interesting. *Busbyi* appears to be coincident in range with the kauri forest, for I am not aware that any specimen has been found south of the parallel to the north of which that timber is now growing. The typical *hochstetteri*, of which the Waitapu specimen of Sir James Hector is an example, was found, as already stated, on the mountain-range between the valley of the Pelorus and that of the Maitai, which flows into the Nelson Haven. I have already mentioned the localities in which the so-called dark *hochstetteri* has been got, and it becomes an interesting point to determine how this variety should have a place on both sides of Cook Strait, and upon an island so isolated as Stephens Island, and yet should never have been found within the area from which the Picton shells have been obtained. I am not at present in a position to solve the puzzle, but I have thought that it might interest the members of the Society to hear some of the known facts in regard to the distribution of land-shells, in order, in the first place, that they may understand the difficulty of solving puzzles of a similar nature, and, in the next place, in the hope that it may stimulate observation and inquiry in relation to our own particular instances.

I need scarcely call your attention to the fact that questions affecting the distribution and dispersal on the face of our globe of all forms of life (using the words in their widest sense) have acquired extraordinary importance amongst naturalists since the publication of "The Origin of Species," and that numberless theories have been propounded to account for the anomalies often presented to us in connection with this subject. One favourite theory, not yet entirely abandoned, has been founded upon supposed frequent and radical changes in the distribution of land and water, but this theory has gradually lost the support of those whose opportunities of observation have been most extensive, and we are being taught to look to the existence of other and yet of necessarily highly effective means of dispersal, in order to account for the facts which observation has brought under our notice.

It has been shown, however, that in considering the questions of distribution and dispersal no group of animals presents greater puzzles than land-shells, for, as Darwin pointed out, almost all oceanic islands, even the smallest and most isolated, are inhabited by members of this group, generally endemic, though frequently mixed with species found elsewhere; and yet it seems almost impossible to conceive how (except where the agency of man can be referred to) organisms which are very speedily killed by immersion in

salt water could have passed over the vast tracts of ocean which frequently separate their present habitats from the nearest continental areas in which closely-allied forms are found. Nevertheless, the fact that such islands as New Zealand, the Sandwich Group, the Canaries, the Cape de Verde Islands, St. Helena, and others equally remote from continental lands, possess numbers of endemic forms shows that the means of dispersal, whatever these may have been, were sufficient to bring about their occupation by a large variety of forms in this particular group of animals.

In connection with these facts attention has been pointedly called to the circumstance that the forms of land-shells are very stable, and that they have, indeed, continued with little change through many geological periods, and therefore that time must be treated as a most important factor in bringing about the distribution which we now find to exist. As an instance of this stability of form, Wallace has pointed out that most of the land-shells found in the Miocene and Pliocene formations in England are similar to, and many of them almost identical with, species still living in England; that, in the Eocene, ordinary forms of many of the existing genera, especially of *Helix*, *Clausilia*, *Pupa*, *Bulimus*, *Glandina*, *Cyclostoma*, *Planorbis*, *Paludina*, and *Limnæa*, have been met with, and he specially mentions that one species of *Helix* found in the British Eocene is still living in Texas, whilst some of the existing Brazilian sub-genera have been found in a fossil condition in Eocene strata in the south of France; and he further mentions, as a still greater proof of the stability of this group, the recent discovery, in the coal-measures of Nova Scotia, of two species of *Helicidæ*, both of living genera, some specimens of which were obtained from the hollow trunk of a *Sigillaria*, and others, in large quantities, in a bed full of stigmarian rootlets, and he adds that between the shells so found and living species of the same genera the most minute examination has failed to detect the slightest difference in form or microscopic structure. Looking to these facts he points out that, in estimating the importance of peculiarities or anomalies in the continued existence and geographical distribution of the present living land-shells, as compared with that of many of the higher forms of life, we must always bear in mind the possible and even probable higher antiquity of the former.

I have already mentioned all that is at present known of the local distribution of the specimens of *Paryphanta* now before you, but this peculiarity is merely analogous to that of some of the other forms of life, both animal and vegetable, in these Islands. Amongst our birds, for example, you will at once call to mind the restricted ranges of the huia, of *Nestor notabilis*, and of some other species. In our plant-life it

is well known that slight differences in latitude often determine the range of many species, and therefore the comparatively restricted range of the different shells before you need cause no surprise, more especially when we compare it with the peculiarities in this respect which are found to exist in other oceanic islands. The Sandwich Islands afford a notable example of such peculiarity. They have yielded between three and four hundred species of land-shells, all or nearly all of which are said to be endemic; and the average range of any species (according to the observations of the Rev. Mr. Gulick, the chief authority on this subject) is five or six square miles at the outside, whilst some are restricted to but one or two square miles, and only very few have the range of a whole island. It is even said that some valleys, and often each side of the same valley, possess their own peculiar species.

The case of Madeira is a somewhat singular one. Wallace tells us that about fifty-two species of land-shells have been found in Madeira and forty-two in the small adjacent island of Porto Santo, but that only twelve are common to both islands, though all, or almost all, are distinct from their nearest allies in Europe and North Africa.

Now, all this is very singular; and yet so great has been the stimulus given to inquiry by the writings of Darwin that we are gradually becoming acquainted, through the observations of a host of naturalists in all parts of the globe, with means of dispersal of this class of animals which must have acted for all time, and may fairly account for its present condition of distribution. Darwin himself made many experiments on the power of land-shells to resist sea-water, and these were sufficient to show that it was quite possible for them to be carried in driftwood for many hundred miles across the sea, and this, according to Wallace, coupled with their power of living for long periods without food, is, as I believe, probably one of the most effectual modes of their dispersal. As an instance of such means I may quote the following passage from Mr. Hickson's "Naturalist in North Celebes." Speaking of the fact that many of the squirrels, rats, and bats of the Philippine Islands and of Celebes are identical, or very similar, and that this is not to be wondered at, for that they could easily be drifted from the one island to the other on drifting timber, he says that "the opportunities afforded to arboreal animals to emigrate from one island to another are not so infrequent as might be supposed. During the heavy rains of 1882 the Wanada River brought down vast numbers of forest-trees, and many of these must have drifted to sea with a considerable crew of squirrels, mice, caterpillars, and other animals." And he mentions the remarkable fact that after the eruption of Krakatoa, in 1883, a female green

monkey was found on some floating timber in the Sunda Straits. She was terribly scorched, but completely recovered, and was still alive when he wrote.

In this connection Wallace points out that Nature can afford to wait, and that, if but once in a thousand years (and he might have said in many thousand years) two or three minute snails were conveyed to a distant island, this is all that would be required for us to find that island well stocked with a great and varied population of land-shells. It must be remembered, too, that, under favourable conditions, the rate of increase of these animals is enormous. It is not more than three years since a few specimens of the introduced snail now so common in our gardens were seen near Paikakariki, and they were probably the progeny of a few individuals accidentally carried there; but those who have noted the countless millions now swarming and sheltering under the loose rocks near the railway-station there will be quite satisfied that a single pair of these creatures introduced into an oceanic island would be quite sufficient to stock it within a very limited period. In conclusion, I would ask the members of the Society to induce any of their friends who may be engaged in bush-clearing in the west-coast district of this Island, to endeavour to obtain specimens of the dark *hochstetteri*, containing the animal, in order that we may be able to determine, by examination and comparison of its structure with that of other specimens of the group, whether it is or is not entitled to specific distinction. I hope shortly to be in a position to bring before the Society some of the more interesting facts in connection with the anatomy of the animal which inhabits the Picton shell.

Art. XXV.—*Further Contributions towards a Bibliography of the* Dinornithidæ, *the Great Extinct Birds of New Zealand, usually called Moas.—Supplement No. 1.*

By A. Hamilton.

[*Read before the Otago Institute, 13th November, 1894.*]

Since presenting my collection of bibliographical memoranda on the moas, I have been favoured with additional entries from Sir Walter Buller, who very kindly sent me ten slips, and from Captain Hutton, who has also kindly added his valued assistance by noting some that had been left out. A few other notices have been collected by myself, and are now communicated. I trust that I may reiterate the remarks made in my last paper, and ask again for the co-operation of others in making the list more nearly complete.

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Augas, George F...	Savage Life and Scenes in New Zealand. Reports having seen moa-bones collected by Earl on the East Coast, at the mouth of a river. The bird supposed to be 17ft. high. "The natives have strange tales and legends respecting this bird"	..	I.	243	..	1847.
Buller, Rev. James	A reference to the moa, with figure of *Dinornis* skeleton and Maori in costume: taken from Sir Walter Buller's book	Forty Years in New Zealand	..	235	..	1878.
Buller, Sir Walter, F.R.S.	References to the extinct wingless birds of New Zealand	Essay on the Ornithology of New Zealand	..	3, 4	..	1865.
Ditto	Legend of Apa-hapaitaketake and the pet moa, as told in the Native Land Court	Appendix to address of counsel in the Rangatira case	..	..	..	July 18, 1882.
"	Notice of the Remains of the Moa and other Birds formerly inhabiting New Zealand: being in the form of a letter to Archdeacon (now Bishop) Hadfield, and communicated by his brother, Captain Hadfield	Zoologist	..	9197–9200	..	1864.
Dieffenbach, Ernst	Travels in New Zealand	..	I.	140, 417	..	..
"	On the Geology of New Zealand ..	British Assoc. Adv. Science	..	..	..	June, 1845.
Gosse, Philip Henry, F.R.S.	An account of the extinct New Zealand birds, with a plate showing an "Encounter with a Moa"	The Romance of Natural History (2nd ed.)	..	31–40	..	1870.

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Grey, Sir George, K.C.B.	Story of Ngahue, who reports at Hawaiki his discovery of the land which produced the moa and greenstone in abundance	Polynesian Mythology	..	133	..	..
Haast, Dr. J. von, F.R.S.	Notes on the Climate of the Pleistocene Epoch of New Zealand. Notice of *Dinornis* remains in the moraines of extinct glaciers in New Zealand. Considered extinction of moa due to man at a recent date	Proceedings of Geological Society	..	..	..	Jan. 25, 1865.
Hamilton, A. ..	Result of a Further Exploration of the Bone-fissure at the Castle Rocks, Southland. Abnormal sternum of *A. didiformis* figured plate xxiv. (title of plate wrong)	Trans. N.Z. Inst. ..	XXVI.	226–229	XXIV.	Nov., 1893.
Hooker, Sir W. J., F.R.S.	Notice of Mr. Colenso's Early Paper on Moa	London Journal of Botany	III.	3	..	Jan., 1844.
Kennedy, Alex. ..	Frontispiece being plate from Rev. J. Buller's book, as acknowledged	New Zealand (2nd ed.)	..	..	..	1874.
Lydekker, R. ..	On a New Species of Moa (*Pachyornis rothschildi*)	Proc. Zool. Soc. ..	..	479	XXXVIII.	Nov., 1891.
Mantell, Dr. G. A., F.R.S.	Notice of the Discovery by Mr. Walter Mantell, in the Middle Island of New Zealand, of a Living Specimen of the *Notornis*, a Bird of the Rail Family, &c.; with numerous references to moa remains	Proc. Zool. Soc. ..	..	209–214	..	1850.

Author.	Title of Paper.	Name of Publication.	Volume.	Pages.	Plates.	Date.
Newman, Edward..	An account of the Moa remains exhibited by Mr. Allis	Zoologist ..	..	9195–9197	..	1864.
" ..	Account of the discovery and ultimate sale at Stevens's Rooms of the moa's egg from Kaikoura	Zoologist ..	..	34	..	1886.
Parker, T. J., F.R.S.	Notes on Three Moa-skulls, probably referable to the Genus *Pachyornis*	Trans. N.Z. Inst. ..	XXVI.	223–225	..	Nov., 1893.
Potts, T. H. ..	Note from New Zealand. On Moa Remains at the Gorge of the Rakaia; notes on Gizzard-stones seen in 1854	Nature	XIX.	21	..	Nov. 7, 1878.
" ..	Maori Traditions of the Moa ..	Out in the Open. (Published at Christchurch)	..	20	..	1882.
Taylor, Rev. Richard	Mention of moa in various parts. Mentions moa-caves at the Mokau (Pukemapou)	Te Ika a Maui ..	..	124, 132, 237–38, 240, 398	..	..
Wakefield, Edward	Short account of the moa ..	New Zealand after Fifty Years	..	73–76	..	1889.
Wilson, John Alexander	Sketches of Ancient Maori Life and History. Note *re* killing of last moa at Tarawera	Pamphlet reprinted from *Auckland Star*	..	2	..	1894.
Woodward, H. ..	On Wingless Birds, Fossil and Recent	Geological Mag., dec. iii.	2	..	..	1885.

Art. XXVI.—*On the Feathers of a Small Species of Moa* (Megalapteryx) *found in a Cave at the Head of the Waikaia River; with a Notice of a Moa-hunter's Camping-place on the Old Man Range.*

By A. Hamilton.

[*Read before the Otago Institute, 19th June, 1894.*]

The history of the moa is one which will always have great attraction for the student of natural history in New Zealand; and year after year fresh details come to light, which, though perhaps small and trifling in themselves, assist in realizing the outward form and semblance of a family of birds as strange and grotesque as any that have ever existed. Every one is now familiar with the numerous restorations which have appeared in books, but should a specimen ever be captured in the flesh I am afraid the reality would scarcely match the figures we have drawn. Having recovered so many practically complete skeletons, the general forms of several genera are known; but whether they should be clad in black like the cassowary, in silver-grey like the rhea, or in brown like the emu, is quite uncertain. It is only quite lately that Dr. T. J. Parker has recognized facts which in all probability show that the heads of some individuals were topped with a crest of feathers. It is quite possible that the neck and head may have been adorned with caruncles or wattles, brilliantly coloured.

Maori tradition, which ought to be full of references to the appearance of the moa, does not help us much. In Sir George Grey's "Poetry of the New-Zealanders" (p. 138) is given a song which Mr. Colenso translates as follows (Trans. N.Z. Inst., vol. xii., p. 87):—

> Produce and begin the talk of old,
> The story of the very earliest times
> Of the great ancient men:
> Thus let it be; begin with the very beginning of all—
> With the chief Kahungunu;
> So that the bird's plume now present,
> That is to say, of the moa,
> Shall be stuck into the hair of my principal chief.

Mr. Colenso made diligent inquiries of old Maoris regarding the plumage of the moa, but, with the exception of the beautiful feather said to have been found at Whakapunake, he could hear nothing reliable. This one was said to be like that of the peacock; it did not differ a bit in its glossiness and

variety of colours, in its length, and in its ocellated appearance, its great beauty; altogether it was exactly like that of the feather of the peacock. Hawea, the native who gave this story, wrote afterwards to say that he had talked over the matter with some friends who had recently come from Whakapunake, and they had said that the celebrated moa on the mountain near their home had twelve of these beautiful round-eyed feathers like those of the peacock.

I have no doubt that this wonderful feather was really a peacock's feather derived from some trader or sailor, and that the information given by Hawea will not help us to picture any of the moas. In one of Dr. G. A. Mantell's papers he says, quoting a letter from Mr. W. B. D. Mantell, "And if the native traditions are worthy of credit the ladies have cause to mourn the extinction (?) of the *Dinornis*. The long feathers of its crest were by their remote ancestors prized above all other ornaments: those of the white crane, which now bear the highest value, were mere pigeon-feathers in comparison."

I once heard from Mr. F. C. Sturm, who was a very early settler in Hawke's Bay, a story of his quest of a reputed moa-feather many, many years ago. The possessor was a chief living some distance inland from Wairoa. After reaching the place the chief produced a bundle of mats, and, after carefully unrolling a number of them, came to a finer and more valuable mat, which contained the *waka* in which was the "moa-feather." Judge of my friend's excitement and disappointment when the treasure turned out to be the red horse-hair plume from a dragoon's helmet.

Mr. John White, in a letter to Mr. Travers (23rd July, 1875),* says, "I forgot to say in my last letter that I have seen many old chiefs who have seen the moa-feathers worn in the heads of the old chiefs when the relators were boys. These men describe them as in some instances about 2ft. long, some 18in., some 12in., some 6in. long, with the down from the top of the quill to within the width of a man's hand at the top, the top being flat like the feather of the tail of the peacock. I think that I have in my MSS. the names which these feathers were called."

In the *Otago Daily Times* of the 5th April, 1873, is the following: "Referring to the statement that live moas have been seen recently in New Zealand, Mr. Ebenezer Baker, Clerk to the Resident Magistrate's Court in Wellington, informs us (Wellington *Post*) that some years ago he found a moa's feather perfectly fresh near Tolaga Bay. It was about 18in. long, and apparently of the underpart of the wing. The feather was a long while in his possession, and was admitted

* Trans. N.Z. Inst., vol. viii., p. 81.

by those acquainted with the subject to be a fresh one from a moa." This is charming and conclusive. Another find of moa-feathers was made by a Dr. Nelson, at the Waipara, in 1858, as recorded in the *Otago Witness* (12th January). They were beautifully preserved fossils; but, alas! a fossil fern had in this instance been taken for the object desired.

From traditions and mistakes we must turn, then, to actual relics. Thirty years ago the celebrated York specimen was found at Tiger Hill, and the shafts of the feathers still remained on parts of the skin attached to the pelvic region. These were described by W. S. Dallas in 1865 (Proc. Zool. Soc., p. 262). Nothing, however, remained of the fluffy part of the feather.

The first paper describing any well-preserved feathers was read by Captain Hutton before the Wellington Philosophical Society in 1871,* and a figure was given which represents an average moa-feather very fairly. These feathers were found, together with moa-bones, buried in the sand, about 50ft. from the surface, at the junction of the Manuherikia and Molyneux Rivers.

About the same time (12th January, 1869), Dr. Thomson, of Clyde, sent to the Colonial Museum twenty feathers found 18ft. below the surface, between Alexandra and Roxburgh. Some of these are in the Museum. The remains found in the Earnscleugh cave, on the Obelisk Range, included the fine neck now in the Otago University Museum, and this retained a number of the shafts of feathers.

The Museum † has also specimens of moa-feathers collected by Mr. Taylor White from a cave near Mount Nicholas and at Queenstown. Specimens from both of these caves are in the Otago University Museum.

Mr. White had a considerable number of well-preserved feathers in his possession until recently, and some of these are now in the Museum of the Hawke's Bay Institute at Napier, and the remainder in England; and in a second paper, in vol. xviii. of the Trans. N.Z. Inst., p. 83, he mentions that one feather—a large one—was pure white.

Professor Owen, in his work on "The Extinct Birds of New Zealand" (vol. i., p. 442), figures a feather, in a woodcut, which is utterly unlike anything that could ever come from a moa. Probably the original sketch was merely a diagram roughly drawn to show the distribution of the colouring on the feather.

Mr. Hill some years ago found a splendid impression of a feather in a deposit of very fine pumice-mud, containing leaves,

* Trans. N.Z. Inst., vol. iv., p. 172, pl. ix.
† *Vide* Trans. N.Z. Inst , vol. viii., p. 101.

&c., of existing species of New Zealand plants, and has described it as a moa-feather.*

The feathers still remained on the metatarsi of a specimen of *Mesopteryx didinus* described by Professor Owen,† and are of a grey colour at the base, deepening into reddish-brown at the top. The legs being feathered so far down must have given a curious appearance to this species. The specimen described came from a cave on the Queenstown side of the Old Man Range.

These feathers are not double-shafted.

A paper on moa-feathers by Dr. Hector was taken as read at the February meeting of the Wellington Philosophical Society in 1880, but I do not think it has ever been published.

In 1876 Dr. Hector found on some very ancient Maori weapons in the British Museum what he considered to be undoubted moa-feathers.

The matter is fully discussed in Owen's work, p. 449, *et seq.* Professor Owen, however, thinks the feathers were those of a large kiwi. It is unfortunate that any doubt should exist, but the specimens in question were lost, and consequently cannot be further examined.

The only instance in which moa-feathers have been found applied to any purpose by human agency is the case I recorded last year‡ of the strip of skin with feathers sewn on to the skin-mat found wrapped around a skeleton in a cave in Upper Taieri. These feathers belong to Dr. Hocken, and I have brought them down to-night to show them in connection with those more recently discovered.

At the time I noticed them they did not correspond exactly with any known examples. Now, however, I have several amongst the present find which exactly correspond, and confirm the original identification. Fortunately, in this case, the feathers can be assigned to an individual moa of a small species, which has hitherto been known as *Megalapteryx*.

I have now to offer for your inspection a number of feathers of this small moa found by myself in a cave in one of the gorges of the Waikaia. This river and its head-waters pour down from the rugged schistose range called the Old Man Range. During the winter the upper parts of the river, and the White Comb district in particular, are practically inaccessible, and the few gold diggers in the creeks and river-beds are cut off from the outer world by the snow-drifts. I visited the district at Christmas time, and, leaving my horse at an accommodation-house known as Vernon's, walked

* Trans. N.Z. Inst , vol. xxi., pp. 318–20.
† Zool. Soc. Trans., vol. xi., pt. 8, No. 4, p. 257, plates 59–61, 1883.
‡ Trans. N.Z. Inst., vol. xxv., p. 488.

on with a guide to a digger's hut some three or four miles further on. Whilst on the journey a torrent of rain descended, and the rivers rose so rapidly that we were practically shut in for two days. Fortunately, however, the cave I was anxious to examine was accessible, being within a few hundred yards of the hut, and about half-way up the steep slope of the side of the gorge. Thick fern covered the face of the slope, but this was of comparatively recent growth, as less than seven years ago the whole gorge was thickly covered on both sides with a dense bush, chiefly of *Fagus*. Chinese diggers, however, accidentally caused a great fire, which denuded the whole face of the country for miles, and now the only remains in this gully are the blackened stumps and trunks of the larger trees. The huge schist blocks which strew the slopes of the ravine form admirable shelter-caves, and these are in many cases absolutely dry. This dryness, and the fine dust resulting from the disintegration of the rock, seem to favour the preservation of animal remains. The cave was not large, say 6ft. in height at entrance, the floor rising and the roof lowering till they meet about 8ft. in. The floor also sloped towards the left side looking into the cave. At the lowest part, where the floor joined the wall, the fine dust was thickest, and here I found the greater number of feathers. Together with the moa-feathers were those of *Ocydromus* (weka), morepork (*Athene*), parroquet, &c. Owls must have frequented the cave in considerable numbers or for a long period, as there were numbers of the pellets ejected by them. Under a large block near the entrance I found a hollow space containing a number of feathers and a dried rat; the fur seemed somewhat mottled, grey and brown, and the size of the animal much less than the black Polynesian rat.

I had been led to examine this interesting neighbourhood in consequence of the finding of a very complete specimen of the dried leg of a small species of moa (known as *Megalapteryx*) by Mr. McLeod, a miner living in the neighbourhood. The leg still retains the dried skin and muscle, and carries a quantity of double-shafted feathers, mostly of a silky nature, and tipped with a lighter shade of brown. It is remarkable as coinciding with Professor Owen's specimen (assigned to *M. didinus*) in having the metatarsus feathered. This extremely interesting specimen was found in the cave after the fire had burned away the mass of creepers and shrubs which had grown up over the entrance, and I have little doubt but that the remainder of the body was burned at the same time. The dried leg is now in my possession, and I am glad to say that Dr. T. J. Parker, F.R.S., the Director of the Otago University Museum, has kindly consented to describe it in detail. The only feather of a new type is one of a purple colour, 55mm.

long and about 5mm. wide from end to end. The remainder are of various shades of brown with a lighter tip. Those best preserved show the double-shafted character very plainly, but there is no doubt that some of those which have no trace of a secondary shaft are true moa-feathers. This is, no doubt, owing to the different character and function of the feathers on the different parts of the body. Thus, in the emu the feathers from the back are harsh and wiry, and without the double shaft, but in the young state, and from the under-surface of the body, they are double-shafted and soft and silky.

It took me all day to fully examine this small cave and two similar ones near it; from all three I obtained the same type of feathers. In each of these caves were abundant traces of owls. I collected six or seven hundred feathers, besides those still remaining on the leg. As soon as it was possible my guide and myself crossed the stream in front of the hut, and climbed the range to a considerable elevation, with the intention of visiting a place called Gorge Creek, but we found the water in the creek too high to cross. The whole country at this elevation has been burnt, and, instead of large tussocks of snow-grass and fern, is covered with sorrel and the scarlet pimpernel (*Anagallis*). A number of caves were examined, and in two we found moa-feathers, but not in any quantity. A curious bright canary-coloured feather of considerable size was found, which I can only refer to a yellow variety of *Stringops*.

Moa-hunters' Camp.

The day was hot, and I was not sorry to commence the descent from the range. The country above the Gorge Creek has a considerable extent of fairly level, swampy hill-tops, covered with the huge white stranded rocks (called white comb). In passing across a small plateau of perhaps three or four acres, surrounded by swamps, I noticed on the bare surface of the ground thousands of flakes of various-coloured quartzites. A little further on were groups of Maori ovens, and quantities of small fragments of moa-bones. I picked up a number of the flakes, one or two pieces of rough implements, and one fragment of a polished tool. If it had not been for the burning of the huge grass tussocks this ancient Maori camp would have been quite hidden. A space of fully two acres was thickly strewn with chips and flakes of stones, which do not occur anywhere near. I was informed that there are two similar camps within sight of this one, but I could not spare the time to visit them.

There is absolute evidence in this case of the use of the moa as food. The quantity of bones lying by the ovens in

which they were cooked, and the comparative absence of any other inducement (wekas being the only other possible prey) for hunters to visit and camp on such an inhospitable spot, all point to these being moa-hunters' encampments, to which blocks of suitable stone have been brought from afar to serve as knives for the feast. The caves and shelters in the huge mass of mountains close at hand have furnished some of the best-preserved specimens of the moa yet found, and were, no doubt, a summer feeding-ground of the moa, to which yearly expeditions were made.

The forms of the stone implements are different from the majority of those found on the coastal encampments, and some approach the leaf-shape so closely as to preclude the suggestion of chance, and seem to indicate their use as points for spears or darts. The majority of the flakes were of the "turtle-backed" type, and probably used for cutting purposes. Their size, however, was very small compared with the monsters found at the Shag Point camp, an average specimen being about 75mm. long by about 30mm. wide, while the Shag Point ones are sometimes 220mm. long and 80mm. or 90mm. wide. I also found a thin disc of slate, sharpened at the edge, about 90mm. in diameter. These discs are not uncommon in the older middens along the coast-line.

Art. XXVII.—*Zoological Notes: (1.) Arboreal Nests of Bush-rat* (Mus maorium); *(2.)* Paryphanta hochstetteri *found at Low Levels at West Wanganui.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 12th March, 1894.*]

Some few weeks since Mr. H. V. Gully observed a nest of a rat in the branches of a small tree or large shrub at Awaroa, near Totaranui. On his mentioning the circumstance to me, at my request he sent for the nest, which I now exhibit. It was at a height of from 4ft. to 5ft. from the ground. His attention was drawn to it by observing a rat leaving it and descending the stem of the tree. On examination he found there were two or three other nests near by, and in one of these there were four young rats. From the appearance of the mature animal Mr. Gully believes it to be not of the common type (*Mus decumanus*), but rather of the same species as those which appeared in such swarms in the spring of

1884, referred to in vol. xvii., page 199, and spoken of there as *Mus maorium*.

The nest does not show any large amount of architectural skill, and is composed chiefly of the dead leaves of sedge and *Cordyline*, with a few dead leaves from trees.

I am informed that the flat whereon these nests were found is liable during floods to be submerged.

I am unaware that this arboreal nesting habit of the rat has been observed before.

ADDENDUM.—The foregoing paper elicited further information respecting the occurrence of nests in trees. From Motueka and Riwaka, Mr. F. Huffam and Mr. H. White give instances of finding nests in branches of trees and shrubs. Mr. J. Dall, of Collingwood, is also well acquainted with numerous instances, and several persons in Nelson have also observed the same, while Mr. Richmond Hursthouse assures me that years ago in Taranaki he used to find the nests of the small bush-rat at some considerable altitude from the ground, generally concealed among the foliage of kiekie (*Freycinetia banksii*).

I may add that all observers are unanimous in declaring the species with the arboreal habit as being identical with the small bush-rat of 1884, and this therefore tends to prove that there are still survivors among us of that great invasion.

PARYPHANTA HOCHSTETTERI.

The specimens of land mollusca exhibited were collected on my recent visit to West Wanganui. They were found at a place not more than 50ft. or 60ft. above sea-level, and where the bush had been partially cleared away. I took note of the surroundings, and found that on each occasion when success rewarded our search it was either more or less under the shade of hinau trees (*Elæocarpus dentatus*), the berries from which were strewn on the ground. The mollusca may very easily be overlooked, as they lie very close generally, in a small depression (self-made, I presume) in the ground, and underneath the dry leaves and rubbish. I did not think these were *hochstetteri*, as the usual habitat is at a considerable altitude, but Professor Hutton has kindly examined them, and has so identified them.

Art. XXVIII.—*Remarks on the Rats of New Zealand.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 8th October, 1894.*]

Many persons would inquire, "What is to be gained by the study of the life-history of a rat?" In answer, I would reply, "The life-history of a rat will give a small portion of historical evidence in regard to the land which it inhabits."

This evidence is of the greater value where it extends backward into the history of the past, whereon no written records are existent. Take, for example, the land which we New-Zealanders still speak of under the familiar term of "Home," though many of us have never lived there, and others, such as myself, never expect to see it again.

In Professor W. Boyd Dawkins's "Monograph of the British Pleistocene Mammalia" is a synoptical table giving nearly the latest information on the distribution of the mammoth and his associates in time, and from it and a few other sources we gather that in the loams and gravels of Post-pliocene age, and in the corresponding caves, there have been found, together with the bones of the larger mammals (as elk, horse, gigantic deer, lion, and ox), the minute remains of such small creatures as the mouse (*Mus musculus*), the water-rat (a vole, *Arvicola amphibius*), the short-tailed field-mouse (*A. agrestis*), the long-tailed field-mouse (*A. pratensis*), the mole, the shrew-mouse (*Sorex araneus*), and the musk-rat (*Sorex moschatus*). From this list you will notice, in looking backward on the far-away historical past of Britain, as illustrated by osteological writings, that neither *Mus rattus* (the black rat), which is considered to be the original rat of Europe, nor *Mus decumanus* (the grey rat), commonly called the Norway rat, which invaded Europe from the eastward during recent times—that neither of these two rats lived in Britain in those early times. As we have the knowledge of the late arrival of the Norway rat in Europe, so we may assume the black rat came forward, mysteriously impelled to emigrate by that remarkable instinct which is inherent in all species of rodents, but at so remote a date that written testimony to the fact is wanting.

It is probable that both species of rat made use of man as a ferryman across the English Channel. But as yet I have no evidence that the black rat has been found on board the shipping, either in former days or at the present time.

I am inclined to think that the black rat—which we have now in New Zealand—is a dweller in the fields and forest,

and is averse to the propinquity of man, and, if so, would rather be classed under the head *Arvicola* (a dweller in the field). The name *Mus* is synonymous with "thief," and so rightly describes *M. decumanus;* and *M. musculus*, "*Musculus*" or the little thief, is a very fitting name for the mouse, who follows civilized man into all lands, feeding and travelling chiefly at the expense of his biped companion. Yet I have known this small creature make long migratory journeys over land and river in the early days of New Zealand, and which are mentioned in my former paper "On Rats and Mice." See Trans. N.Z. Inst., vol. xxiii., p. 194.

When the grey rat (*M. decumanus*) increased in Europe, especially in Britain, it destroyed, or caused the destruction of, *M. rattus*, the original or older inhabitant of the country, which in those parts is said to be now extinct. More than fifty years ago I and my brother John were accomplished rat-catchers, and from the age of, say, seven years had destroyed or hunted every rat we caught sight of. But we never saw a black rat, which is good proof that this rat was then extinct in England. We spoke of rats and water-rats, but I think we distinguished the water-rat from the other not by apparent difference, but simply because it tried to escape by diving in the water of the river. Nevertheless, at a very early age we distinguished between the two species of field-mice, which we caught and tamed. We were assisted by our playmate, a reddish-brown, long-coated water-spaniel, in these hunts, and, if the water was discoloured by mud, could trace the course of the diving rat by a bubble of air which would rise to the surface at a distance of every 2ft. or 3ft., and so pointed the direction and progress, under water, of our prey. These occasional bubbles were, I suppose, expended air which the animal at times liberated from its lungs. If I remember right, a wounded wild duck, when diving, could be traced in the same manner.

I am thus particular to prove that the black rat was then not found in England, for we have the question to solve, How did the black rat come to New Zealand?

This question of when and how the black rat came to New Zealand is not readily answered. Of the Chatham Islands Mr. A. Shand says, "Native rats, called 'kiore,' were common to the island, but it is believed they were not eaten by the Morioris. The native rat was exterminated by the Norway rat, which escaped ashore from a wrecked whale-ship." No mention is made of the black rat at the Chathams by this writer. (Polynesian Society Mag., vol. iii., p. 87.)

The Norway rat and the mouse certainly came to New Zealand as passengers of our European shipping; but did the European black rat (*M. rattus*) also arrive in the same way,

but at a date previous to the coming of *M. decumanus* to Europe and the extermination of its kindred in England? Although I have written to several gentlemen who have access to good libraries I am still unable to fix the date when the black rat disappeared from Europe. And this question still remains unanswered—namely, Could the black rat be brought by the early whalers? From the Chatham Island episode we might suppose that such could not have been the case. How, then, did it come? Is it from the shipwreck of a Spanish or Portuguese ship many, many years before the time of Captain Cook?—a ship which came ashore at the northern part of New Zealand, and from which landed part of the crew—*pero*, a dog, and "kiore pakeha," the black rat. This may have been the case. On my arrival in Canterbury (South Island) in 1855 I found grey rats, the *M. decumanus*, and most likely also the native rat "kiore maori," living in small communities on the grassy plains: these I did not then distinguish from their larger *confrère*, both being greatly of the same colour. Having asked what the Maori rat was like, I was answered by those who had preceded me to the country that it was of a red colour; therefore my search was for many years the looking for a red rat, something like the colour of a squirrel.

Although I lived in different parts of the South Island for ten years I never saw a black rat, but on coming to Hawke's Bay I noticed them within three months' time. As the Bluff Harbour, in the South Island, was a place of call for whalers, if the black rat had been with them then, I should have found black rats there, and at Lake Wakatipu in 1860. So I do not think this rat was on the whale-ships, but that they brought the Norway rat (*M. decumanus*). But the black rat is now found in Westland and Nelson, and so must surely have arrived by shipping in recent times to those places.

Dr. Ernst Dieffenbach, in 1840, would seem to have found the black rat in great plenty in the north of New Zealand, and from what he says it seems probable that this rat had been known to the Maoris for many years, and long previous to the introduction of the Norway rat. But I will let this traveller speak for himself: "There exists a frugivorous rat called 'kiore maori' (indigenous rat) by the natives, which they distinguish from the English rat (not the Norway rat), which is introduced, and called 'kiore pakea' [*sic*] (strange rat). On the former they fed very largely in former times; but it has now become so scarce, owing to the extermination carried on against it by the European rat, that I could never obtain one. A few, however, are still found in the interior—viz., at Rotorua, where they have been seen by the Rev. Mr. Chapman, who describes them as being much smaller than the

Norway rat. The natives never eat the latter. It is a favourite theme with them to speculate on their own extermination by the Europeans in the same manner as the English rat has exterminated their indigenous rat. . . . The common mouse of Europe has also been introduced."

Mr. John Edward Gray, F.R.S., keeper of the zoological collections in the British Museum, who worked up the account of the fauna of New Zealand which supplements Dieffenbach's work, adds, "Called 'kiore' by the natives. Said to have been introduced at an early period by European vessels." Polack says, "It would be interesting to see whether it is the European, the Indian, or the New Holland rat that has been introduced, or if there may not be more than one kind" (vol. ii., p. 185).

On describing his first attempt to ascend Mount Egmont, Dieffenbach says, "At sunset we arrived at the cleared summit of a hill, where we found several houses for provisions, which are always built on posts to guard against the rats, and also two other houses. A thick forest surrounded this place on all sides. We had taken up our abode in an old house, where the rats ran over us the whole night."

On a second attempt he reaches the top of Mount Egmont, and "On the summit of the mountain I found the entire skeleton of a rat, carried there, no doubt, by a hawk" (vol. i., p. 144).

So far as I can see, Dieffenbach never himself mentions seeing the Norway rat in New Zealand, nor did he seem at that time to be aware that *M. decumanus* was to destroy *M. rattus* in England, and, so far as I know, throughout Europe, as at the present time. Yet we have evidence that the Norway rat was well known to the Rev. Mr. Chapman and himself by the comparison as to size between the "kiore maori" and the Norway rat, and, to my judgment, I would suppose an implied resemblance in colour between the two, but that the Norway rat was considerably larger than "kiore maori." This, in the main, would be fairly correct. On the other hand, I do not understand that *M. rattus* would in numbers scamper over the resting traveller the whole night. Rather, I would say, these must have been *M. decumanus*. But neither Dieffenbach nor Maori, as reported in this work, speak of other than two rats—one the imported or stranger's rat (*M. rattus*), and another the indigenous rat, "kiore maori." Who shall decide this point? I for one greatly doubt the black rat having the boldness to come near a sleeping man. I have never known them other than in the open field or forest.

On closer consideration of what Dieffenbach says I am inclined to the conclusion that he did find the Norway rat in

New Zealand. But his wording is very obscure. He says, as quoted above, "A few, however, are still found in the interior —viz., at Rotorua, where they have been seen by the Rev. Mr. Chapman, who describes them as much smaller than the Norway rat. The natives never eat the latter."

Now, surely it is here clearly stated that the Norway rat is never eaten. But in vol. ii., p. 130, he says, "The flesh of Europeans they consider salt and disagreeable, a curious physiological fact if true, and they stated the same regarding the flesh of our dogs and the introduced European rat."

It is a great pity that the scientific names of the rats spoken of are not made use of, for in one sentence it is said that the "kiore maori" was destroyed by the English rat (*i.e.*, *M. rattus ?*), and in the following one the destroyer is called "the European rat," which presumably must mean also *M. rattus*.

Then, it is said the flesh of the European rat (?) is disagreeable to the taste; elsewhere it is said they "never eat the latter," the name in the preceding sentence being that of the Norway rat (*M. decumanus*). It is also remarkable that the destructive habits of the Norway rat against its congeners are not remarked on, but rather the black rat is placed in this position of the destroyer of its kinsmen in New Zealand. This position of the rats one to the other is astonishing when we remember that the black rat (*M. rattus*) has long ceased to exist in England, having been quickly exterminated by the emigrant grey or Norwegian rat (*M. decumanus*). Nevertheless, at the present time we have in parts of New Zealand all three species of rat—the "kiore maori," the black, and also the grey rat—living in the same forests, as, for example, I have taken all three at Wimbledon, in Hawke's Bay, where I now reside; but the "kiore maori" are not nearly so numerous as the black or grey—the last is most plentiful. In a former paper I remark on what Captain Crozet says of the animals of New Zealand: "The rats are similar to those of our fields and forests," which would indicate the black rat (*M. rattus*). For if the *M. decumanus* had been referred to he should have said the rats of our towns and sewers, or barns and stacks.

This, then, would go to prove that "kiore pakeha" (*M. rattus*) was seen in the north of New Zealand long before any vessels were sent to southern seas to kill the whales; which leaves the question, How and when did the black rat reach New Zealand?

The first mention of the presence of the black rat in the South Island, so far as I am aware, is by Mr. Reischek, a collector of natural-history specimens about the year 1885, in a paper published in a former volume of "Transactions of the

New Zealand Institute." I have a remembrance that he spoke of rats both grey and black in colour, but did not distinguish the species.

In Transactions, vol. xxv., p. 503, Mr. Colenso, in a footnote, says, in his criticism of my paper in vol. xxiv., p. 554, "Mr. White, in the passage I have just quoted, says, 'and possibly two distinct species' (as if this was also something new). Why, this was well known so long ago as Darwin's visit to New Zealand in 1835; and I have mentioned the two foreign species in various old publications; in particular, some fine black rats (m. and f.) I obtained here living in Hawke's Bay about 1846, and, as they seemed somewhat different, sent them (in spirits) to England to Professor Owen." Mr. Colenso has misunderstood my meaning, which was that the small grey rat ("kiore maori") of the North Island might have some specific distinction from the "kiore maori" found in the South Island. I did not refer to *M. rattus* at all, but to the *M. maorium* specimens taken by myself in Hawke's Bay as compared with those found in Marlborough and Nelson.

The second mention of *M. rattus* in the South Island is by Sir James Hector (Transactions, vol. xxv., p. 535), who said that "this rat (*M. maorium*) was entirely different from others sent from Nelson at the time of the irruption of rats referred to" (formerly described by Mr. Meeson), "and which he was unable to distinguish from *M. rattus*." The time referred to must be considerably more than ten years ago, and I have no later information as to whether this rat is now found in the Nelson Province. From an official report by Mr. C. R. Douglas, of the Survey Department, "On the Westland Alps," the following is quoted: "The Norwegian rat, which was no doubt responsible for some destruction, and which swarmed in the country at one time, is now becoming extinct from some cause or other, and the native and black rats are taking its place—two animals perhaps not quite so destructive as the grey gentleman."

This, you will allow, is a most remarkable occurrence, and would seem to be a reversal of the position out of which the late Charles Darwin and Dr. A. R. Wallace have made capital, as indicating the survival of the fittest in the struggle for existence—how the Norwegian rat, having exterminated the black rat of Europe in some mysterious way, probably by cannibal feasts or otherwise, had since emigrated to the then new country of New Zealand, and at once, in a very short space of time, thoroughly exterminated the frugivorous rat of New Zealand, the "kiore maori." Now we have it said that many in the North Island, both Europeans and also the Maoris themselves, suppose the black rat to be the original "kiore maori," for it has so long dwelt among them, and

is so readily distinguished from the large grey Norwegian, that the present generation of New-Zealanders have recollection of it from their early childhood, even to this day; that the black rat is now on the west coast of the South Island, and is increasing in numbers rapidly, and, wonder of wonders, the fierce Norwegian is becoming the scarcer of the two, and even the native rat, so much smaller than the other two species, and which for many years was said to be extinct—said by Dieffenbach to be destroyed by the "kiore pakeha" (the black rat) before the year 1840—and which native rat Mr. Colenso could never find, although offering great rewards to the Maoris for specimens — that this small inoffensive *M. maorium* is actually to be found, and is said to be increasing in numbers in Westland, notwithstanding the close propinquity of the two fiercer species. History does not repeat itself in this case, and I would ask the question, Has the identity of our black rat been sufficiently studied, so as to clearly prove that it is *M. rattus* of Europe? We may assume that *M. rattus* is a later arrival to New Zealand than *M. maorium*—that is, "kiore maori"—for the former was not known to the early settlers in the South Island, and I consider that the latter was present, but not identified; being smaller, and of a grey colour, it was thought to be a three-parts-grown Norwegian.

Mr. Cheeseman, in the Transactions, vol. xxvi., p. 219, says, "Mr. Colenso, whose knowledge of the natural history of New Zealand and close acquaintance with the Maori race should give great weight to his opinions, believes that no living European has seen the true Maori rat—that it has vanished from the list of living beings, and has become as extinct as the moa or dodo. Others, whose views are, perhaps, equally entitled to attention, believe that the small black rat still found in forest districts, and on the outlying islands, and which occasionally makes incursions in considerable numbers into the settled portions of the country, is the true indigenous species. But, whichever of these views is correct, a comparison of skulls found in old Maori eating-places seems to have established the fact that the Maori rat was identical with a species widely distributed in Polynesia, and which has been known to have been unintentionally carried by the Polynesian natives from one group of islands to another." (On what authority? — T. W.) "The Maoris have a tradition they brought the rat with them from Hawaiki, and, until remains of the animal have been found in deposits older than the time of the Maori occupation, we must attribute considerable weight to that view." These remarks are made by a dweller in the North, and show the estimation in which the black rat is held in those parts.

The Maoris have a name for a certain rat — "pouhawaiki" — and the following are extracts from correspondence in reference to this name. Mr. Tregear says it is the Norway rat (*M. decumanus*), and that a certain Maori bearing this name is now living at Little River, Canterbury. Hearing this, I wrote to this Maori gentleman, asking the translation, or true meaning, of the word "pouhawaiki," but, so far, have received no answer.

Mr. E. C. Goldsmith, of Gisborne, sends me the following by letter: "Gisborne, 17th July, 1894.—I do not know of the black rat from personal knowledge, but the Natives inform me that it was called by them 'pouhawaiki'; that it lived in the bush, but did not come into the houses; and that it was good to eat."

On my writing again for further information, and stating that Mr. Tregear says "pouhawaiki" is the Norway or grey rat, and that any South Island native knows that as a common word for "rat," and that I never myself saw a black rat in the South, I received further particulars under date the 10th August, 1894:—

"'Pouhawaiki,' according to my informants, who should know, having eaten them, are the original Maori black rat, living in the bush. One informant tells me that he has not seen any since 1851, but up to that date there were plenty of them, and that he has eaten them, and that they were very good. He also points out that the name is 'pou-uhawaiki,' which would prove its being the proper name for this rat.

"I know nothing on the subject myself, and have never seen the native black rat, though I have been camped out in the bush during the last twenty-six years in places far from civilization, the only rat we get there being the common brown one."

This above information was kindly collected for me on the east coast of the North Island; and the following is given me from the opposite coast, by Mr. W. H. Skinner:—

"New Plymouth, 17th August, 1894.—In answer to your question *re* the indigenous rat of New Zealand, I have asked the question of four reliable old Maoris myself, and got our Native Agent to put the same question to a roomful of natives, and in every case the answer was, 'There was only one rat in New Zealand in old times, and its name was "Po-hawaiki" or "Pou-hawaiki." This is the rat our forefathers used to eat.' As far as I could gather, this rat was in the country when their ancestors came over from Hawaiki.

"You say, 'I never saw a black rat there' (South Island). Mr. Clarke, late Chief Draughtsman of Westland, tells me he has seen numbers of black rats on the west coast of the other

Island, and that they are now increasing, and gradually driving the grey rat out" (*M. decumanus*.—T. W.).

On the 24th August, 1894, Mr. Skinner wrote from Hawera,—

"In talking to an old chief of the Taranaki Tribe at Te Namu, Opunake, called Tautai, I put the question to him (by the help of our interpreter) about the native rat. He said most emphatically that the old New Zealand rat was called 'kiore maori,' and that 'pohawaiki' is the name of the European rat (grey).

"I write this at once, in case you are making use of the previous information. I cannot understand why the natives quoted in my last letter should give the names differently, but this man Tautai is an undoubted authority on such things. His age is about eighty years, and his faculties are very clear. He is now, I think, the head chief of the Taranaki Tribe."

This correspondence is very interesting as showing the extreme difficulty which arises in transmitting oral testimony on matters which were well known only fifty years ago—in fact, at a time when few of the older generation still survive.

Tautai, in saying that *Mus maorium* was named "kiore maori," agrees with what Dr. Dieffenbach wrote on this subject; but, owing to my desire not to put specially leading questions in my inquiries, we have received no mention from Tautai as to the *M. rattus* being named "kiore pakeha," or any theory as to why the native rat became so scarce. On the whole, I accept Dieffenbach's statement that the English or black rat (*M. rattus*) was called "kiore pakeha," "the foreign rat." This would go to prove that *M. rattus* came to New Zealand some time previous to the arrival of *M. decumanus*, the grey rat, because the Maoris told Dieffenbach that "kiore pakeha," which he understood to be *M. rattus*, had destroyed "kiore maori." What surprises me in this connection is that Dieffenbach seems entirely ignorant of what is now an asserted fact, viz., that the grey rat has destroyed the black rat in Europe. This would lead one to suppose that at that date, 1839–40, the battle of the two species had not been carried out to the bitter end. Yet both he and the Rev. Mr. Chapman seem to have been well acquainted with the Norway rat. And I am led to the conclusion, as stated previously, that *M. decumanus* was then in New Zealand, having come in ships bringing the early colonists.

In my paper, "On Rats and Mice," published in the Transactions, Vol. xxiii., p. 200, which was read before your Institute in 1890, is the following quotation from "Darwinism," by A. R. Wallace: "The black rat (*Mus rattus*) was the

common rat of Europe till, in the beginning of the eighteenth century, the large brown rat (*M. decumanus*) appeared on the lower Volga, and there spread more or less rapidly till it overran Europe and generally drove out the black rat, which in most parts is now comparatively rare or quite extinct. This invading rat" (*M. decumanus*.—T. W.) "has now been carried by commerce all over the world, and in New Zealand has completely exterminated a native rat, which the Maoris allege they brought with them in their canoes from their home in the Pacific."

From this you will see that Dr. Wallace, and, as far as I can judge, all scientific naturalists, have in an unaccountable manner overlooked Dr. Dieffenbach's report, taken from the Maoris in 1840, that it was *M. rattus* and not *M. decumanus* which had decimated their native rat; so I may take the credit for having turned up this remarkable fact after the lapse of so many years.

From the above it would seem that *M. decumanus*, the Norway rat, appeared on the confines of Russia or the centre of Europe nearly two hundred years ago, and, from our experience of the habits of migration common to most rodents, we may assume that they came in regular armies, in which case their influence would be as speedily apparent as that of a victorious incursion of the human race, and the black rat would be quickly swept away. How, then, do we find the black rat in New Zealand previous to 1840, and can it really have been brought from Europe, or is it from a country south of the line?

This black rat had, in 1840, been so long in the North Island of New Zealand that it had exterminated the native rat, or, rather, caused it to be almost procurable. When it first arrived it could only be by the advent of a very few animals, and not in the army of myriads which would come forward to invade Europe—for this rat must have come by ship, possibly from a wrecked ship. These few black rats would take a number of years to increase to a formidable number, and we must not compare their rate of increase with that of *M. decumanus* in after-years, which latter rat would have a constant accession to its numbers from the continued stream of shipping arriving in New Zealand from Europe. When the vessels come alongside the wharf the rats during the night escape along the ropes connecting the vessel with the pier.

The black rat is, I believe, not yet found in Canterbury, Otago, or Southland, which would seem to indicate that it is not spread by the shipping, or very rarely. Professor Hutton tells me that he has no knowledge of its existence in Canterbury.

The Maoris have a tradition that the "kiore maori" (*M. maorium*) was purposely carried in a box on board the Aotea canoe, and so brought as a valuable commodity or special pet from Hawaiki to New Zealand by the first Maori emigrants. This I look upon as a story founded on the fact that these people, on arrival, found their old acquaintance the "kiore" already established in New Zealand: or it may have survived the voyage, hidden among the vegetable productions with which the canoes were provisioned; but this seems hardly probable, unless rats are able to slake their thirst with the brackish bilge-water entering a vessel by leakage. This rat is found on the outlying islands of New Zealand, together with the wood-hen (*Ocydromus*), which has no power of flight, and this would suggest the idea that such islands were at one time a part of or connected with the main land, and so lead onward to the theory of a once gigantic continent reaching from New Zealand to Norfolk Island, New Caledonia, and other Pacific islands.

I have, in speaking of the black rat, already given you the chief remarks which Dieffenbach makes on the "kiore maori." He further states, when referring to the rights of landed property among the Maoris, "It was formerly very common that the fat of the native rats ('kiore') killed on such lands should be given to the principal proprietor; and in many cases a title to land seems to have been derived from the fact of having killed rats on it. Thus a chief will often say, 'This or that piece of land is mine; I have killed rats upon it.'"

He also states to the effect that a favourite speculation among the Maoris was that, as the "kiore maori" was destroyed by the introduced "kiore pakeha," so would the Maori people disappear before the European. This is a remarkable theory when we remember that so few white men were in New Zealand in 1840.

The following *karakia*, or incantation, is given by Dieffenbach, for a translation of which I am indebted to Mr. Edward Tregear:—

He Karakia Kiore Maori.	*An Incantation for the Maori Rat.* (*That it may come to the pit and be killed.*)
Taumaha ki runga,	Thank-offering above,
Taumaha ki raro,	Thank-offering below,
Ki taku matua wahine,	To my mother,
I ki ai taku kiore,	Said my rat,
Ma te reke.	By the snare.
Taumaha! Taumaha!	Thank-offering! Thank-offering!
Etaka te po, etaka ki Tuhua.	The night falls; it falls at Tuhua.
Etaka te ao, etaka ki Karewa.	The day falls; it falls at Karewa.
I tutu ai he kiore.	The rats gather together.

Or, less literally,—

> Give thanks to those above;
> Give thanks to those below,
> According to my mother,
> My rat he said
> By the snare (will be caught).
> Give thanks! Give thanks!
> The night falls; it falls at Tuhua.*
> The day comes; it falls on Karewa.†
> Hence the rats assemble.

In the Transactions, vol. xxv., p. 49, is a note on *Mus maorium*, Hutton, by Sir Walter L. Buller, who at the same time exhibited a specimen which was taken at Nelson at the time of the great irruption of rats into that district, recorded by Mr. Meeson: "It is identical with the species of rat collected by Mr. Reischek some years ago on the Little Barrier and other islands in the Hauraki Gulf, specimens of which were taken by me to England in 1886. I compared those with specimens sent to the British Museum by His Excellency Sir George Grey about the year 1848, and found the rat to be the same. Mr. Oldfield Thomas, of the Zoological Department, . . . is of opinion that the species is identical with the Polynesian rat (*Mus exulans*) (Peale, Expl. Exped.). This form is known to have a wide range, there being specimens in the British Museum from the Fiji Islands, from Norfolk Island, and from New Caledonia." Mr. Oldfield Thomas, by comparison of the bone framework of this rat with measurements of remains found by Professor Hutton in Maori kitchen-middens, or feeding-places, considers it identical with the rat which was contemporary with the extinct moa.

During the discussion which followed Sir W. L. Buller's paper, "Captain Mair remarked that this little rat was exactly similar to that inhabiting White Island, in the Bay of Plenty." (Transactions, vol. xxv., p. 535.)

I am in doubt as to what in future will be the scientific name of "kiore maori." Professor Hutton, of Christchurch, writes me as follows: "The Maori rat (*Mus maorium*) has been identified in the British Museum as *Mus exulans* (Peale), which is now its name. This rat was originally described from Fiji." On the other hand, Professor T. Jeffery Parker, Otago, writes, "I may say that Mr. Oldfield Thomas, of the British Museum, one of the leading authorities on mammalia, considers the Maori rat a good species. I believe he calls it *M. maorium* (Hutton), not *M. exulans*, but am not quite sure."

---

* Tuhua = Mayor Island, Bay of Plenty.

† Karewa rock, seven or eight miles off Tauranga, where the tuatara lizard is caught.

I am now of opinion that a sociable species of rat which was to be found on the Canterbury Plains, near Oxford, in the years 1855–56 was *M. maorium*. Something of their habits are described in the Transactions, vol. xxiii., p. 195: "Taking a spade and the pointers, we would beat around, and the dogs would presently come to a stand. Going up, an area of some 10ft. would be noticed of a nice green colour among the prevailing brown, being free from tussock [*Poa australis*], and covered by a small flattish-leaved grass, whose leaves had their points curved or bent towards the ground. At distances apart in this green patch were numerous rat-holes. . . . From recollection, they [the rats] were reddish-brown, and perhaps white underneath, of a fair size, and not unlike the Norway rat (*Mus decumanus*). Still, I feel certain they could not be the Norway rat, but a distinct species of a more social disposition, for full-grown ones lived together to the number of eight to fourteen, and were not a family of young rats."

Some four years ago (1890), on reading Mr. Rutland's paper in the Transactions, giving an account of the so-called Maori rat (*M. maorium*) in the north part of the Southern Island, I set to work to try and find the same rat in the forests here, where I am located—Wimbledon, Hawke's Bay. The grey or brown rats had so great a variety of shades of colour and size that this was no easy matter, and a collection of skins and measurements had to be made of all sorts before I could come to a decision. Ultimately, what I had at first considered to be the young of the larger species (the Norway rat) proved to be entirely distinct, and to have special characteristics peculiar to themselves.

This rat (*M. maorium ?*) is coloured brownish-grey, mixed with black hairs; black hairs plentiful from forehead to nose, which is pinkish-skinned; belly, dirty white, also light slate-colour, very dark fur underneath. This white slate colour is often seen on the underside of the wild rabbit in New Zealand. Yellowish-brown stripe down breastbone (not always); coloured on legs down to claws, which are pink, with white hairs; ears are often, or nearly always, jimped as with small excrescences on edges (as if from disease), but this seems a distinct peculiarity of the species; face broad, outline Roman, possibly from hair standing outward naturally; ridge of bone between ears, on back of head, very prominent, sometimes with patches of black colour on the underside of the skin. A second description is: Male, ears jimped with fighting (?), reddish-brown, with black hairs slightly longer; short black hairs on head, giving a stand-up look to the coat, as of an animal very cold or sick (this may be taken as a distinct characteristic of the variety). Nose and mouth pink; under-jaw, belly, inside fore legs, blue-white, with dark under down. Faint bar of reddish

down breast; darker brown colour down front of fore-legs; dark-reddish ring of colour round to inside hind-legs at the hock, in the lowest of the long body-hair; top of back darker than sides; tail smooth, hardly any short hairs; toes white, hind-toes with patch of dark colour on middle knuckles; forehead or front of face looking to project, or rounded by hairs standing out; whiskers black. As with the other rats and mice, the thumb on each fore-foot is wanting the top joint and nail, and one of my specimens was actually without any sign of the thumb itself.

Of the few specimens taken, a male and a female (*M. maorium?*) were forwarded to your Museum at Napier, together with a specimen which seemed distinct from either *M. maorium* or *decumanus* both in shape of outline and in having the light colour of the belly extending up the sides; also a specimen of *M. rattus*, taken at the same time. I have never been able to find out whether all four specimens are now in your Museum.

To support the supposition that the black rat was a survival or escapee from a Spanish vessel, besides the name "*pero*," a dog, which is similar to the Spanish, we may speculate on the name "Pani," sometimes spoken of in Maori tradition as a woman the wife of Tiki, who, having come to New Zealand and been well received by the natives, in return for this kindness made a special voyage to a far country, and returned bringing that one-time-valuable fruit the kumara, which previously had been unknown in New Zealand. This name "Pani" may be the Maori rendering of "*Espani*," a Spaniard, and "Pani" is mythologically said to be the wife of E'tiki, a deified ancestor of the Maori race. Dieffenbach remarks on the word "*kaipuke*," a ship, as being similar to a Spanish word. No reasonable explanation can be given of its meaning, treated as original Maori—*kai*, to eat; *puke*, the hill—and I believe this name for ship is not found among other Polynesian peoples.

I should have expected that the "kiore maori" would have been placed in the class *Arvicola*, or "dwellers in the field," owing to its habits and to its being a strict vegetable-feeder. In the forest it eats the berries of the hinau-tree, and perhaps of the tawa and pines. It is quite common to see the little heaps of the empty oval cases of the hinau-berry, having a minute hole perforated by the "kiore maori" at the one end, through which the kernel has been deftly extracted—a proof that the animal picks up a single berry, and each time returns to a favourite seat, where he makes his feeding-place. But I have never seen berries of the other forest-trees so collected.

This rat also eats certain leaves, such as the karamu, and possibly of other shrubs. The black rat also eats leaves, as

proved by internal examination. The sociable rats living on the Canterbury Plains would perforce require to eat grass and minute plants and their seeds, and may have supplemented this fare by insects and grasshoppers.

They were mostly found at considerable distances from any speargrass, the roots of which might otherwise have been eaten.*

Mr. Douglas reports that the native rat is on the increase in Westland, as also is the black rat, but that the Norway rat is becoming scarce. This is a remarkable instance of the revival of a species at one time supposed to be extinct, and a singular reversal of the survival of the fittest, the reason of which, and the watching for future developments, is a study of great interest, worthy the consideration of the best scientists of the present time.

Besides the two specimens of "kiore maori" forwarded to Napier Museum I sent some half-dozen skins to Professor Hutton, who deposited them in the Christchurch Museum, where they can be seen by those interested in this study.

I will conclude this long paper with two anecdotes, which I think refer to *M. decumanus*.

When employed bushfelling about a year ago, and working among a clump or collection of trees which were all firmly tied together by the runners of supple-jacks and kiekie, it was necessary to go from one tree to the other and cut a deep scarf in each, and so work backward through these trees, which would not fall until the last of their united trunks had been also given the preliminary scarf on the side to which it was desired they should fall. This is one of the most arduous and dangerous duties of the bushman, for the mass of entanglement leaves little room for the use of the axe, or for the escape of the worker if he miscalculates the position of his surroundings. When plying the axe beneath a tree which was enveloped in numberless green heads of the climbing kiekie, something fell from above with such force on to my left shoulder that I was somewhat hurt, and thought it was a good thing that the piece of dead bough had not struck me fair, but had glanced off. The thought then came, What size was it? On looking about I saw a grey rat on the ground partially stunned. Thinking it might be a "kiore maori," I endeavoured to secure it, but, being come to itself again, it quickly made off.

The second is of a grey rat, supposed part grown, who used to come in the daytime and sit before a window—not of glass, but of calico—as the large blow-flies, attracted by the light, settled on the calico and walked up it. This small rat

* Maori, "*Tara-mea*," pointed thing—*Aciphylla colensoi*.

would seize each fly, not taking it with its mouth, but in its two hands, like a man fielding a cricket-ball. It would then sit up demurely, and, still holding the fly in its hands, would eat it with great relish, and then sit patiently waiting for the arrival of the next fly. Location, head-waters of Oreti River, Otago, in 1860–61.

In the "Transactions of the New Zealand Institute," vol. xxiii., p. 201, I gave the following measurements: From point of nose to top of head—*M. maorium*, 1½in.; *M. decumanus* and *rattus*, 2in. Hind leg of Maori rat—from hock to end of toe, 1in.; of the other two species, 1½in. These are not measurements of the bone, but outside the hair.

	Maori Rat.				Black Rat.	
	Male.		Female.		Male.	
	No. 1. In.	No. 2. In.	No. 1. In.	No. 2. In.	No. 1. In.	No. 2. In.
Snout to root of tail ..	$6\frac{4}{16}$	$5\frac{1}{8}$	4	$5\frac{3}{8}$	$7\frac{12}{16}$	$7\frac{3}{8}$
Length of tail	$5\frac{11}{16}$	$5\frac{1}{8}$	$4\frac{6}{8}$	$5\frac{3}{8}$	8	$7\frac{1}{2}$
	$11\frac{15}{16}$	$10\frac{2}{8}$	$8\frac{6}{8}$	$10\frac{6}{8}$	$15\frac{12}{16}$	$14\frac{7}{8}$

The tail of *M. rattus* is longer than its body, that of *M. decumanus* is of shorter measurement than the body of the animal. The former rat is much lighter in build and general appearance than the other, and the Maori rat is considerably the smallest of the three.

P.S.—I have just received the following information from a gentleman living near Dunedin:—

"10th September, 1894.—I have made inquiry about the black rat, and find it is rather scarce now about the import-sheds. When I was in the Universal Bond, as a clerk, twenty-four years ago, they were plentiful in the bond, and every few days one would be caught in the traps. Those caught were smaller than the grey rat, and had long, rather furry hair. Their muzzles were sharper and shorter than the common rat, and altogether they were a superior-looking creature to the usual rat.—A. R."

This letter describing a black rat in Otago is a surprise to me, for I never saw a black rat in the Wakatipu district when living there. This will likely go to prove that a black rat is found near the shipping of most New Zealand harbours. Some years ago I found the dead body of one at the entrance to Messrs. Murray, Roberts, and Co.'s stores at Port Ahuriri, Napier.

Our honorary secretary, Mr. W. Dinwiddie, gives me the following information :—

"I have got a derivation of 'Pohawaiki' from Toha Rahurahu, a native clergyman of the Wairoa, through Mr. James Grindell, licensed interpreter. He says, *po*=night, *hawaiki*= the far country, and the combination means that the beast was a mysterious visitor from an unknown land shrouded in darkness. He says that is the recognized derivation. He remembers the old rat—some dark, some light, and others grey or speckled. [The old black rat turns grey.—T.W.] Mr. Grindell says he recollects them (?) in New Zealand up to about 1860. But he says there is no distinction between 'pohawaiki' and 'kiore pakeha.' It was the brown rat" (which presumably is *M. decumanus*.—T. W.).

Mr. Dinwiddie further informs me,—

"The black rat was not known in Europe before the sixteenth century. It is first mentioned by Gesner in his 'Historia Animalium,' published in Zurich about 1587. It is commonly supposed to be of South Asiatic origin. The brown rat (*M. decumanus*) is probably from the same quarter. Bell says South Asia. Buckland says, 'It is now agreed by most naturalists that it is a native of India and Persia, that it spread onwards into European Russia, and was thence transferred in merchant-ships to England and elsewhere (p. 62).

"Pallas fixes 1727 as the date of its appearance in Russia (Bell). It arrived in Paris 'beginning of eighteenth century,' and in London 'about the same time.'

"The brown rat speedily mastered the black in England, but it is difficult to say at what date they would be said to be exterminated. They must have been common enough up to the first quarter of this century, especially in shipping localities. Buckland, writing in 1857, says the brown rat has 'nearly exterminated the black rat.'

"Bell (2nd ed., 1874, largely rewritten; 1st ed., 1839) says the black rat is now rarely found, except in old houses in large cities. Fifteen or twenty years ago this animal was not rare in several localities in Warwickshire, 'but we now doubt the possibility of obtaining a single example.' He records the finding of a colony at Pitlochry, in Scotland, in 1860, as 'the first ever heard of within the memory of any person living in the country.' In Ireland it is now rare, though not so thirteen years ago.

"In 1859 Sallin exhibited specimens to the Linnæan Society, and both he and Buckland speak as if they were readily obtainable. Buckland says at that time the chief locality was the Isle of Dogs. I should think that even later than that it was to be found among shipping on the Thames.

"I can find no authority as to whether the black rat exterminated the Maori rat. It is generally supposed that the brown rat is responsible (Buckland, p. 63). That seems to have been the impression of the early travellers and missionaries in New Zealand (E. Dieffenbach and Rev. T. Chapman, quoted in Trans. N.Z. Inst., vol. iii., p. 1). But it seems probable to me that both brown and black had a hand in it. No doubt both species were brought by ships, and existed, or even exist, in the colony together, as, according to Moseley ('Challenger' Exp.), they do in Malay Islands and elsewhere.

"I may mention that Darwin found rats at Galapagos and Keeling, which he calls black rats. Although somewhat smaller than the English variety, he does not think it necessary to make a new species.

"Chapman says that in old times there was a second native rat larger than the Norway rat, which was always rare (Trans. N.Z. Inst., vol. iii., p. 1)."

I take this opportunity to thank those gentlemen who have so kindly assisted me in collecting material for this paper, and will now give an extract from "An Introduction to the Study of Mammals," by Sir W. H. Flower and Richard Lydekker (just come to hand) :—

"The brown or Norway rat (*M. decumanus*) is a heavily-built animal, growing to 8in. or 9in. in length, with a bluff, rounded head, small ears, and a comparatively short tail, which is always shorter than the head and body combined, and generally not longer than the body alone. The colour is a uniform greyish-brown above and white below, the ears, feet, and tail being flesh-coloured. Black varieties, which are often mistaken for true black rats, are by no means rare, but the differences in size and proportions form a ready means of distinguishing the two. The brown rat is believed to be a native of Western China, where a race (*M. humiliatus*) has been discovered so like it as to be practically indistinguishable. Both this and the next species agree in their predaceous habits, omnivorous diet, and great fecundity. They bear four or five times in the year from four to ten blind and naked young, which are in their turn able to breed at an age of about six months, the time of gestation being about twenty days. The black rat (*M. rattus*) is a smaller and more lightly-built species, generally not more than 7in. in length, with a slender head, large ears, and thin tail of about 8in. or 9in. in length. The colour is usually a glossy bluish-black, somewhat lighter below; but in the tropical variety described as *M. alexandrinus* the general colour is grey or rufous, and the belly white. The disposition of the black rat is milder than that of *M. decumanus*, and the white and pied rats kept as pets mostly belong to this

species. In many localities where it was formerly abundant it has been entirely superseded by *M. decumanus*, but it is said that in some parts of Germany it has been lately reasserting itself."

This article is, I believe, contributed by Mr. Oldfield Thomas. A figure of the heads of these two rats is also given.

In answer to my inquiries, Dr. James Hudson, of Nelson, writes, under date 18th September, 1894,—

"The migration of rats which occurred here in 1884, and which Meeson reported, was certainly a dark rat, but not 'black.' It was very much smaller than the ordinary Norwegian rat—in fact, about midway in size between a mouse and that animal. It was again fairly numerous in 1888, and occasionally since, but is very scarce just now. The Maoris here called it the native rat. When I get a good specimen I will send it to you. The only two kinds of rats I have any knowledge of here are this small rat and the ordinary Norway rat."

Note I.—Mr. Grindell, as above quoted. says "pohawaiki" is the same animal as "kiore pakeha." Which animal is he meaning, *M. decumanus* or *rattus?* I suppose he refers to *M. decumanus*, for you notice how these terms have different values according to the species prevalent in districts wide apart. If we take Dr. Dieffenbach's report in 1840, "kiore pakeha" is *M. rattus*, which no doubt was the correct name in north New Zealand at that time. *M. decumanus* was probably found only on the coast, near the larger harbours, at that date. Dieffenbach writes "kiore pakea." He drops the "h" in most Maori words as written now.

Note II.—Hunting the water-rat.—At times this rat, when exhausted by diving, would come to the surface, keeping its body inclined perpendicularly, and remain seemingly perfectly motionless, with only the small pointed tip of the nose and nostrils at the junction of air and water, so getting a breathing-space, till the disturbed mud cleared away and he was detected. The hair would be wet, and plastered close to the body, illustrating the old saying, "As wet as a drowned rat."

The name "kiore" would seem the general term signifying "rat" throughout Polynesia—as Samoan, *'iole;* Tahitian, *iore*, a rat; Hawaiian, *iole*, a mouse; *iole nui*, a rat or rabbit (*nui*, large).

Of other words meaning "rat," besides "pouhawaiki," are "hinamoki," which would seem an older form, taking notice of the Moriori word *hinamoko*, to squeak. Investigating the structure or composition of *hina-moki*, we find *hina*, grey hair of the head, which would seem to mean white rather

than our standard of a grey colour, as of a rat or rabbit. If so, it seems hardly applicable in this case. But *hina* is a personification of the moon, and supposing the original form to have been *mokai*, rather than *moki*, we have "Hina's pet," the animal moving about at night. For comparison see *hina-po*, twilight (*po* = night); *hina-pouri*, very dark (*pouri* = darkness); *hina-moe*, sleepy (*moe* = sleep). "Hinamoki," a rat, was likely used by the Moriori of the Chatham Islands, and by a pre-Maori race in New Zealand.

A third name is "maungarua," the cave in the hill (*rua*, a hole, a cave for storing crops). *Maunga* is also to dwell or reside (in); *rua*, the storeroom. This last definition is very suitable for a rat. A fourth name for a rat is "riroi" (*roi* = fern-root). Dieffenbach describes a store cave seen on his journey between Lake Taupo and Rotomahana (vol. i., p. 378):—

"The sides of this small ravine consisted of pumice-stone or tufa, and here the proprietors of the potato-ground had hollowed out deep caves, which were secured from without, and were full of potatoes. Snares made of flax-leaves were laid all around the entrance for the purpose of destroying the rats. One of the holes filled with potatoes had been left open for the use of travellers, as is customary in New Zealand, and to us this liberal custom proved a great relief."

Elsewhere Dieffenbach mentions that the Maoris were necessitated to build *pataka*, or storehouses elevated on poles or posts, to preserve their provisions from the rats. They also kept the bones of some of their friends in boxes at the top of poles set up in the *pa* or fortified enclosure where they lived.

Some of these rat names may have been only in temporary use during the time a chief was named *kiore*—as *Nga-te-kuri*, the descendants of *kuri*, the dog; *Nga-te-ruru*, the descendants of *ruru*, the owl.

Conclusion.

In this paper I purposely refrain from making a summary of the various statements therein, for my opinion is that after a lapse of ten or twenty years the subject will be more readily understood when the then history and habits of the three species of rats are remarked on and compared. For example, a careful inquiry should be made at once to discover whether *M. rattus* is frequent about the stores at different shipping-places, and if any of the Polynesian rats arrive in the small vessels which convey fruit and island produce to New Zealand. If it is correct that the "kiore" came to New Zealand in the Maori canoes from Rarotonga or elsewhere, may not this same arrival of *M. maorium* to New Zealand be still continued by European shipping at this date? If so, we have no certain proof that the "kiore" was not exterminated and

afterwards reintroduced to New Zealand. The finding of this rat in such an out-of-the-way place as Wimbledon would almost be conclusive proof that the "kiore" of the Maoris was not exterminated, but was only greatly reduced in numbers.

I am firmly convinced that Dieffenbach found *M. rattus* in great numbers in the north parts of New Zealand, as far south as Lake Taupo, and Taranaki and Wanganui on the west. But *M. rattus* was not known in the South Island from Nelson through Canterbury to the Bluff in 1855–57, and if now found at these places it has been recently introduced. In the South Island *M. decumanus*, and not *M. rattus*, would compete with or destroy *M. maorium*. But in the north we are clearly told by Dieffenbach (1840) that the Maoris informed him *M. maorium* was destroyed by "kiore pakeha," the foreign rat, and that this rat was not the Norway rat, but the English rat (*M. rattus*).

Note.—*M. rattus* in country places lives in the forest or field, and is not seen in the houses.

I would direct your notice to the undoubted fact that neither Dieffenbach nor Mr. J. E. Gray, of the British Museum, mentions that the Norway rat (*M. decumanus*) was found in New Zealand about the year 1840; in proof of which Mr. Gray heads the paragraph thus: "The Rat—*Mus rattus*, Linn.?" but seems still to have doubts as to what rat is meant, for he says, "It would be interesting to see [that is, himself to see] whether it is the European, the Indian, or the New Holland rat that has been introduced." By "European" *M. rattus* is referred to, for you will also notice Dieffenbach in his description says, "which they [the natives] distinguish from the English rat (not the Norway rat) which is introduced." And further on this is varied thus: "owing to the extermination carried on against it by the European rat"; and a few lines further on, "in the same manner as the English rat has exterminated their indigenous rat": "(not the Norway rat)," which is between brackets, but "the English rat, which is introduced"—that is, the black rat (*M. rattus*).

M. decumanus is not mentioned as introduced, but "The Mouse—*Mus musculus*." "The common domestic mouse of Europe has also been introduced."—Dieffenbach. The cat, pig, horse, ass, sheep, and ox are next mentioned; the dog having previously been spoken of.

This reading of the rat question has seemingly been overlooked by our scientists, and, if it had not been for the heading, "The Rat—*Mus rattus*," attracting my notice, I also should possibly have passed it without comment.

Since writing this paper I have found a portion of a rat's skin which, from the dark under-fur, may have belonged to a "kiore," *M. maorium*: upper or back reddish-brown, sprinkled

with black hairs; under or belly and sides a faint sulphur-colour, with dark-bluish down at the base of the yellow-tinted hairs. This down is not visible unless the hair is parted.

When Mr. Gray says, "It would be interesting to see whether it is the European, the Indian, or the New Holland rat that has been introduced," &c., he has entirely thrown over Dr. Dieffenbach, and is following the leading of Polack, who says, "Called 'kiore' by the natives; said to have been introduced at an early period by European vessels." Take special notice: Gray is speculating on his own account about *M. maorium* and not alluding to *M. rattus*. He had never seen specimens of this rat, and is just leading the reader astray. It is extremely probable that Polack is speaking of the black rat, "kiore pakeha." The "kiore maori" he probably never saw, as it was likely to have at that time become scarce, owing to competition with *M. rattus*.

You will notice also that Gray follows after Polack on the subject of the dog (kuri), or rather Gray leaves both Polack and Dieffenbach, and, although the latter clearly says this dog was entirely different from the dingo of Australia, yet Gray gives this heading to the paragraph: "The New Holland Dog — *Canis familiaris australis*, Desm.; *Canis dingo*, Blumenb." From this we must on no account take for granted anything interpolated by Gray on the subject of the New Zealand "kiore" or "kuri," for he knew nothing whatever about either animal.

The rat seen by Dieffenbach, and most probably by Polack, was the progenitor of the black rat which inhabits the north part of New Zealand at the present time, and which rat, until proved otherwise by osteological evidence, we assume to be identical with *Mus rattus*. This rat, the Maoris told Dieffenbach, was "kiore pakeha," the foreign or stranger rat.

The first to arrive in New Zealand was "kiore maori." Then, in a mysterious manner, comes "kiore pakeha," the black rat. Then, according to Dieffenbach, "the mouse accompanies the early settlers." (The Norway rat, "pouhawaiki," last of all.) That is to say, in the North Island. The black rat was not found in the South Island, and there the Norway rat spread inland some years in advance of the mouse, a fact which I recorded in a former paper.

Art. XXIX.—*On the Bird Moa and its Aliases.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 8th October, 1894.*]

It has long been a subject of discussion among the scientists of New Zealand and elsewhere as to whether the numerous species of the *Dinornis* were contemporaneous with the present Maori race, many learned men maintaining the opinion that a Polynesian people inhabited New Zealand prior to the arrival of the Maori emigrants from the islands of Polynesia. That New Zealand was inhabited by Polynesian people other than those we call Maoris there seems little cause to doubt: in fact, tradition allows that such was the case. But these people do not seem to have been numerous, or of a fighting race, and were quickly conquered, enslaved, intermarried with, and so obliterated from the page of more reliable historical tradition. It is evident that this former people did not entirely exterminate the *Dinornis*, for we can show, through different lines of deduction, that the Maori killed the moa, a certain and conclusive proof of which I will endeavour to present to you in this paper.

In the "Transactions of the New Zealand Institute," vol. xxv., p. 413, Mr. Edward Tregear has a very able paper on "The Extinction of the Moa," in which he treats this subject on the basis of comparative philology. From the word "moa" he deduces the following conclusions: that, whereas this word is used throughout most of the Polynesian islands to denote the domestic fowl (*Gallus bankiva*, var.), and as compounds of the word denote certain parts and attributes of the domestic fowl at those places, consequently, assuming that the word "moa" was brought by the Maori emigrants as a part or integral portion of their vocabulary from those same islands, this word must still retain its original meaning as a domestic fowl, and therefore was not likely to be used as a name for the *Dinornis*.

But Mr. Tregear does not explain this point: When Captain Cook brought and "turned into the forest," and also gave to the Maoris, "pigs and fowls which we brought from the islands," how was it the Maori recognised the pig as an old friend by the name of *poaka*—by which name, with its variants, it is known throughout Polynesia—but seemingly had no more knowledge of the domestic fowl than they had of the American turkey when introduced at a later date? Of this

we have proof, owing to special names built up and originating in the noisy disposition of both species, as *pipipi*, a turkey, from *pipi*, the cry of a bird, the cry of a child. This I take to equal our word "gobbler," or the Scotch "bubbly-jock." Now, instead of the Maori treating the fowl as an old friend and naming it "moa," a new name was invented, founded on an original Polynesian word—*heihei*, noise; Hawaiian, *hooheihei*, a drum, to beat a drum, which would seem to mean the noisy bird, *heihei*, the domestic fowl. This selecting of a word denoting the noisy habit of the fowl corresponds exactly with the origin of our word "hen," proving that the people of Europe and those of far-away New Zealand first studied the habits of the bird and then gave it a name suitable thereto. Professor Skeat gives: "*Hen*, from Anglo-Saxon *henn*, *hen*, *hœn*; a feminine form (by vowel change) from Anglo-Saxon *hana*, a cock, literally 'a singer,' from his crowing; chief form, Latin *can-ere*, to sing." An old word which I remember in my young days, but which now seems obsolete, is *chanticleer*, from the French *chant*, singing, song; *le chant du coq*, the crowing of the cock, which is from the same root, *kan*.

As if to give us double assurance that the word "moa" was already in use, they invented a second name for the domestic fowl, *tikaokao*, apparently from *ti*, to deafen with clamour, and not the word *kaokao*, the ribs, the side of the body, but meaning a sound approximate to the cry of the bird, as "the one who loudly calls *kaokao*." This word *tikaokao* being of onomatopoetic origin—that is, from the cry of the bird—compares with our word "cock." We find the allied form in Malay *kukuk*, crowing of cocks, and *kakak*, cackling of hens; and our word "cackle," from middle English *kakelen*, meaning to keep on saying *kak;* and Sanscrit *kukkuta*, a cock. Now, I will boldly advance the theory that the domestic fowl was brought to the Polynesian islands after the time when the Maori left the islands of Polynesia, which would give some four hundred years till the time of Captain Cook, who found poultry in abundance in many of the islands; and that the Polynesians are the remnant of a people who formerly inhabited a large southern continent now chiefly submerged or disappeared beneath the sea, which gives these people their tradition of "the Deluge"—a land where all kinds of moa and kindred birds existed in great plenty. In this land of giant birds the Polynesian ancestors lived and ate the moa, and in this lost country originated both the bird and its name of "moa." This land may not have disappeared as a whole suddenly, but as the plains became slowly submerged the heights became islands, and so the Polynesian people became navigators of the intervening seas. But in later time some more

sudden convulsion of nature swallowed up the greater portion of these isolated places: this was the Polynesian deluge. In the meantime the former alpine heights, now New Zealand, were allowed time by this gradual change to acquire a certain amount of trees and vegetation where formerly was a region of snow. With this vegetation came also a remnant of different species of struthious birds, and perhaps, at a later date, a few of the then bold navigators "who searched the waters for lost Hawaiki." May not this be the meaning of the name Ha-wai-ki? When the domestic fowl was brought to the islands of the Pacific, the word "moa," being still known but unoccupied, was used to name those birds; but the Maori of New Zealand, having still the skeletons of the moa, and the gizzard-stones, *moamoa*, round about him, in caves and on the surface of the ground, could not well give the fowl the same name, but named it as before mentioned. For example, the Maoris say they brought dogs, rats, and pukeko in their canoes, as giving us to understand that these were the most valuable or portable products of their former home; but not a word about bringing a moa, whether domestic fowl, ostrich, or cassowary. Yet I think it can be clearly demonstrated that the moa lived in New Zealand at that time, and was eaten by these people for several generations after their arrival in the country. But for some peculiar reason they seem to have spoken of the moa under other appellations, possibly owing to some influential person being for a certain cause named after the bird moa, and so the traditions of the killing of this bird have become obscure or disguised. Dr. Dieffenbach says, "It is known that in many of the islands of the great southern ocean the curious custom exists of changing arbitrarily words of the language, and of making others *tapu* or forbidden. . . . I found the traces of a similar custom amongst the natives of Roto-rua. *Wai* (water) has been changed into *ngongi; kai* (food) into *tami*. The name of a place near Tauranga, where a great fight took place and many of the natives were killed and eaten, was Waikeriri, but they now call it Ngongi-keriri. The cause of this singular innovation is that the old word becomes sacred, either from a chief adopting it for his name or from some other event sanctifying it." The next paragraph is interesting: "I heard a curious tradition connected with a totara-tree in the neighbourhood. Near this tree they said their forefathers killed the last moa. From the few remains of the moa that have been found it has been declared by Mr. Richard Owen to be a struthious bird, and of very large size." The few bones then known were found by Mr. Rule and forwarded to England. Date of the above anecdote, 1840.

But for some reason Mr. Rule would seem to have received

or understood a garbled account of these bones—namely, that they were those of a giant eagle called "movie" (Trans. N.Z. Inst., vol. xxvi., p. 253). Dr. Dieffenbach says (vol. ii., p. 195), "To this order (Struthionidæ) probably belongs a bird, now extinct, called 'moa' (or 'movie') by the natives. The evidences are a bone, very little fossilized, which was brought from New Zealand by Mr. Rule to Mr. Gray, and by him sent to Professor Richard Owen (Proc. Zool. Soc., 1839, p. 169). I possess drawings of similar bones, and of what may possibly be a claw, which are in the collection of the Rev. Richard Taylor, in Waimate. They are found on the east coast of the northern island of New Zealand, and are brought down by rivulets from a neighbouring mountain called Hikorangi."* Such would seem to be the information collected or known in England about this bird in 1839. And we may ask on what authority Mr. Rule called the bird "movie" a gigantic eagle. Possibly he might conclude it must have been a bird of prey owing to the Maoris speaking of it as such a fierce and dangerous creature. The Mr. Gray mentioned was the then chief of the Zoological Department of the British Museum. Mr. Gray appended the notes on the fauna of New Zealand to Dieffenbach's "New Zealand." May not the South Island account of *poua-kai*, the giant bird of prey, have been misunderstood on similar lines? I am unable to say if in Maori *poua*, an old person, is pronounced so as to allow of a comparison between that word and *poua-kai*. If such can be done we get *poua-kai*, old people's food, a bird on which the former Maori made his feasts, a bird which was eaten by the people, and not the bird which ate the ancestral Maori. This rendering of the name alters the whole character of the bird. Whether the bird *poua* of the Chatham-Islanders is an allusion to the moa as an old person or to the extinct swan is an open question. It is not spoken of as a bird of prey, but as utilized by man for food. In Maori we find *poua-kaki-wa*, a chief place of residence, possibly meaning "the old people's sleeping-place," and *poua-hao-kai*, a supernatural being who helped to kill Tawhaki, an ogre, who was killed by hot stones being thrown down his throat. This word would seem to mean "the old person who ate greedily," and the reference to hot stones may be merely an allusion to the known habit of the moa of swallowing stones to assist digestion. It must be borne in mind that verbal tradition would contain certain truths distorted in proportion to the lapse of time in which it had been in circulation.

Among the Maori traditions are many which mention the

* "Movie" is here added to Dieffenbach's account by Mr. Gray, following Mr. Rule (?).

killing of *ngarara*, or monsters, such as *ngarara-hua-rau*, called also *karara-hua-rau*, the monster with numerous progeny. Such would seem to be flocks of moas, which probably lived in small parties. This particular creature was killed at Wairarapa by a chief called Tara, after whom is named the lake at Te Aute, in Hawke's Bay.* It was near or about this lake that Mr. A. Hamilton collected many remains of the moa in shallow water, after drainage. May not this lake have come by its name because it was utilized by the chief Tara and his companions when making a surround of a flock of moas, which they forced into the waters of the lake, whereby numbers were drowned, and a part obtained as food? We know for certain no person, whether Maori or any other, ever killed a crocodile or alligator in New Zealand, but that tradition states that a something was killed by such-and-such a person: what, then, is it likely caused the origin of the story? Did a certain brave man kill a *tuatara* lizard, and would the fact be recorded as a great victory? This is hardly likely: yet the *tuatara* is a *ngarara*. Is it not more probable that creature was one or more of the larger species of the moa, which were at that time becoming scarce? In support of this view, Dr. Dieffenbach makes the pertinent remark: "I had been apprised of the existence of a large lizard, which the natives call *tuatera* or *ngarara*, with a general name, and of which they were much afraid, ... and the natives killed it for food" (vol. ii., p. 205); also of animals they consumed—fishes, dogs, the indigenous rat, crawfish, birds, and iguanas (vol. ii., p. 18).

I would draw attention to the fact that the Maori, in the early days of their acquaintance with the pakeha, would seem to have spoken of the *ngarara* and the moa as if they were allied in partnership, or companions. Although we have read of the small bird (plover?) which fearlessly enters the open mouth of the crocodile inhabiting the district of the Nile, and feeds on the leeches which trouble the ugly saurian, yet we can see no reason to suppose that the *ngarara* and the moa should find a mutual benefit to be derived from their living together. The Rev. W. Colenso was told a story of a moa residing on a certain hill guarded by one or more *ngarara*. Dr. Dieffenbach says, "The natives could not understand what induced me to ascend Mount Egmont; they tried much to dissuade me from the attempt by saying that the mountain was *tapu*—that there were *ngarara* (crocodiles) on it, which would undoubtedly eat me. The mysterious bird moa, of which I shall say more hereafter, was also said to exist there. But I assured them I was not

* Te-roto-a-tara.

afraid of these creations of their lively imagination" (vol. i., p. 140). These and stories of a like nature are good evidences that the *ngarara* and moa were in partnership; in fact, that they were one and the same. The additions as to the *ngarara* resembling a magnified lizard (of which small creature the Maoris are as frightened as some Europeans are of a spider or a mouse, or even more so) is just what might be expected, owing to the use of the word *ngarara*, a reptile, in place of the word "moa."

Dr. Dieffenbach is the only authority, so far as I am aware, who speaks of the Maori eating the *tuatara* lizard, and, from the lively fear displayed by the Maori at the sight of even the smallest lizard, it is highly improbable that such creatures were ever used as daily rations. Sir W. Buller, you will remember, turned several *tuatara* lizards into "Maui's garden," and then felt perfectly satisfied that no Maori would venture near the place. How, then, would they catch such things for food, or ever have done so? That the killing of a large bird like the *Dinornis* should be spoken of as the killing of the monster (*ngarara*), and those who killed it be remembered as valiant warriors, is a very different matter from the recording of the killing of *tuatara* for food-supply, or any other purpose. Also, the supposition that the stories of killing *ngarara* in New Zealand at particular places, and by men whose pedigrees show that they lived and died in New Zealand, are simply a remembrance or tradition that the ancestors of the Maori fought with the crocodile in Papua, or lost Hawaiki, or any other place, is simply ridiculous. The Maori has merely confused himself by a one-time change of the word "moa" to that of *ngarara*, and the history of eatings, swallowings, scales, and twining tails are just built up on the magnified image of a wee lizard.

Most of these stories are understood by Europeans to refer to *taniwha*, or mythical monsters. As, for instance, a certain chief had a pet *taniwha*, which is said to have been a whale. But an absurdity of this kind will not prove that all *taniwha* or *ngarara* stories are without foundation. Such stories were once—that is, at the first telling, and for several generations of listeners—related so as to correctly describe all the different incidents of the act. But as time went on the hearers had no standard of comparison to judge by. The moa was now extinct, and the previous introduction of the word *ngarara*, and the placing a *tapu* against the use of the word "moa" for several generations among certain Maori tribes, caused confusion of thought. The moa becoming extinct about this time, the use of the word "moa" became obsolete, and future generations of Maoris—that is, of these particular tribes—continued to rehearse these original stories

of the moa, but still using the nomenclature of *ngarara*—as Dieffenbach says, "*ngarara* with a general name."*

The killing of a second *ngarara-hua-rau* is recounted by a native in the "Journal of the Polynesian Society." In this case the creature is said to be a male, who carries off a woman to be his wife; he is a perfect saurian, but is capable of speaking the Maori language, and there are other incongruities in the tale. The most useful part of the story would seem to be in the name of the place where this occurred—Moa-whitu, the six moas (D'Urville Island). These Maoris are said to have come from the northern part of New Zealand, and so may be a part of those who caused the word "moa" to be *tapu*.

We are unable to account for the Maori words *pero* and *moimoi*, a dog, used only in the North. Dieffenbach mentions a tribe named Nga-te-kuri, "the descendants of the dog," who at one time lived at Kaitaia. When this ancestor assumed the name of Te Kuri is it not possible that the word *kuri*, a dog, was caused to be tapu and *pero* or *moi* used in its place? (Vol. i., p. 218.)

I am unable to produce much evidence as to persons using the name "moa" as a cognomen. In the love-story of Hine-moa we get her name as the girl-moa, and two of her sisters are suitably named Tawake-hei-moa, the neck-ornament of *moa* (feathers?), or the moa-feast, or possibly the noisy moa. Here, it is remarkable, we find the word "moa" in juxtaposition to *hei*, and the modern word *heihei* is a domestic fowl. It is still more curious that the second suitor was named Ngarara-nui, the large reptile: here again we find "moa" and *ngarara* in propinquity, as forming the distinctive names of two brothers. These people lived at Rotorua, and are said to have living descendants at the present time. In the story of the stealing of a pet moa, mentioned in the Transactions, vol. xxv., we are given the original name of the hero as Ahahapaitaketake, which I translate "to keep on going crooked." He had his thigh broken by falling over a cliff, but, notwithstanding this mishap, he secured the moa, and, owing to this accident, was afterwards called Hapakohi (hop and go one). From these similar names it seems more probable that this man was not lamed when stealing the moa, but at some previous occasion, and was then made permanently lame. The name of the woman who was taken from the tribe of the thief as compensation for the loss of the moa is said to have been Hine-moa-tu

* A Maori might use the words "moa" and *ngarara* as having one and the same meaning when talking to a pakeha; but, if the listener already knew *ngarara* as a name commonly used to denote a lizard, the figure of a lizard would be present in his thoughts, and a *ngarara* spoken of as dreadful or powerful would resolve itself into the conception of a crocodile or large saurian, and not that of a 9ft. high bird.

or Hine-mo-atu. If the name is rightly divided in the first place we get the girl-moa, and, if *tu* is short for *utu*, "compensation," the girl in compensation for the moa. Any way, it seems singular that this name should come so very close to verifying the truth of the story.

In Hawke's Bay we have a place or river named Moa-whango, which may mean the loud breathing or hoarse-voiced moa; and a gentleman's property is named Pa-hamoamoa, the village of the gizzard-stones of the moa. In Gisborne and elsewhere are places named Papa-moa, and a cave named Moa-ha.

It is very good evidence for my argument that Dr. Dieffenbach points out that the Maoris, in describing their food-supply, said that in former times they ate such-and-such things, and also the "*ngarara* with the general name." Possibly they actually used the name Ngarara-hua-rau, the reptile with the numerous progeny—not meaning the *tuatara* lizard, as Dieffenbach supposed, but using the form of name adopted in place of the original word "moa," which had long ago been considered *tapu* by that tribe.

Also, it is notable that the Maoris all through New Zealand know the domestic fowl by names not so utilized among the other branches of the Polynesian people. Yet the word "moa," a fowl (Polynesian), is not lost to the Maori, but used to denote the *Dinornis*, and *moamoa*, *ha-moamoa*, to denote moa-stones.

The use by the Maori of *tara-moa* as the name of a plant having many sharp curved hooks on its branches is a score against me, for Mr. Tregear connects it in theory with the spurs of a cock, and other words in which the personality of the domestic fowl would seem to be referred to in Polynesian-island languages. Can the moa have had a partiality to the berries of this shrub?

In spite of the charge of a repetition, I will give a *résumé* of my argument. If the Maori had a knowledge of *Gallus domesticus*, the domestic fowl, in times long ago—say, five or six hundred years back—how come they to have had such a fear of the traditional living thing the moa, a dreadful something which, in alliance with the *ngarara*, a second traditional being of great fierceness, guarded, or roamed through, little-known and inaccessible places, and about the tops of the highest mountains, and lived in caves? These fierce creatures, together or in company, were expected to destroy any person who was sufficiently daring to enter the regions where they lived. Now, is it reasonable to suppose that the Maori considered that a barndoor fowl was the companion of a dreadful crocodile (*ngarara*), and that this small-sized fowl could possibly kill or frighten a stalwart man—a fowl or domesticated

bird, which some persons would have us think the ancestral Maori had bred and utilized as an egg-producer in some former home of the Polynesian people?

Dr. Dieffenbach, about 1839 or 1840, was told that if he attempted to ascend Mount Egmont these creatures would destroy him. Allowing, for argument, that the moa was a barn-door fowl, why did not Dr. Dieffenbach find it on Mount Egmont? or, when he saw the hen in the Maori villages, why did not the Maori say, "This hen will kill you on Mount Egmont if you break the *tapu* of that sacred place"?

Again, how do we account for the tradition of the bringing in canoes from Hawaiki of the dog, rat, and pukeko (*Porphyrio melanotus*), but no moa? On the contrary, Ngahue is said to have killed the moa, and taken by one account its skin, by another its potted flesh, in a calabash from New Zealand to Hawaiki, and told of the land of the greenstone and the moa.*

If the Maori knew the *Dinornis*, sp., as the moa previous to Captain Cook introducing the domestic fowl to their notice, then we can readily see that it would be very unlikely they would call the small domestic hen by the same name of "moa," for, if the Maori had not at that time the living moa, yet they still had the bones and the remains of this gigantic bird of many varieties, the largest of which were dangerous to their most active warriors. With the Polynesians of the other islands it was different, for they had not the moa with them, yet may have kept a remembrance of a bird called moa, which was farmed by man as a food-product. When they obtained the domestic fowl—say, after the Maori exodus—and saw the useful properties of this bird, they may have thought it the bird mentioned in the traditions of their people—the lost bird, the moa. Note the Maori tradition of the wonderful bird *Moa-kura-manu* (the red-feathered bird moa), who, by drinking up the waters of the Deluge, saved the people who had fled for safety to the great hill, Hikurangi (see "Ancient History of the Maori," vol. iii., p. 49). There is also a saying that the moa was lost at the time of the Deluge—*i.e.*, long ago.

Dieffenbach, in 1839, says the Maoris informed him of a food which their ancestors ate before the introduction of the pig. It was "*ngarara* with a general name" (additional words?). This, being the common name for reptile or insect, was thought by Dieffenbach to mean a lizard which was not then found on the mainland—the *tuatara* (*Sphenodon punctatum*)—a specimen of which he ultimately obtained from a European, after offering the Maoris great rewards if they would get him one. Now, Dieffenbach caused this matter of the

* Trans. N.Z. Inst., vol. xxvi., p. 506.

"*ngarara* with the general name" to become more obscure, for he of his own thoughts made the creature to be an iguana. No doubt he was surprised to see the small size of his specimen *tuatara*, but may have got over that by thinking it a young one.

That the Maori ever ate a *tuatara* as ordinary food is highly improbable, for the Maoris have the greatest dread of all kinds of lizards. One species, *Naultinus elegans*, "if a man look at or let it fix its eyes on his own, is a cause of immediate death to that man."* How, then, would a Maori dare to eat such baneful creatures? May we not rather suppose that *ngarara*, with the suffix, was for some reason used by certain tribes to denote the *Dinornis* sp.?

I would further suggest that the word *ngarara* may be a corruption or misused for *ngara* and *ngangara*, to snarl, allied to *rara*, to roar, *kara*, to call; Tahitian, *ararà*, hoarse through calling, hoarseness; and beyond Polynesian proper, Macassar, *ngangara*, to shriek. Possibly the male bird (moa) was *ngarara*, the one who called in a hoarse voice, the nasal sound "ng" being used as a prefix to *arara* or *rara*, to roar, which is lost in Tahitian *arara*, to call in a hoarse voice. The *ngarara* was the loud-calling male bird, and his mate, the female bird, was called "moa." In Moa-whango, a place-name, we get the hoarse-voiced moa, similar to *ngarara* when rendered "the hoarse-voiced one."

This would account for the saying that the two creatures *ngarara* (the male) and moa (the female) lived in partnership in caves on the mountain-side. Then *ng-arara-hua-rau* and *karara-hua-rau*, a monster killed at Wairarapa by Tara, was the hoarse-voiced male moa and his numerous progeny, and not a saurian monster with numerous descendants.

This we can readily believe, for have we not the bones of all kinds of moas with us at this day, and in some places found piled in heaps, as it were, evidence that the Maori had surrounded flocks of moa and forced many into the waters of swamps and lakes, at which places we now get bones in one large collection in a small area? But we find no evidence of any monster saurian having lived in Tertiary times in New Zealand, nor can we thus account for the numerous descendants indicated by the suffix *hua-rau*, and so we may safely conclude that *ngarara-hua-rau* was the male moa and his attendant females, with their young, which the Maori at one time was accustomed to destroy wholesale.

It is currently reported among many scientists that we

* "Departed spirits are said to transfer themselves into this and the former species, and the natives regard them therefore with a certain dread, calling them *atuas* or gods." (Dieffenbach, vol. ii., p. 203.)

have no reliable mention, at an early date of the settlement of New Zealand, of the killing of the moa by the Maori, and I think therefore that the following extract from Dieffenbach's "New Zealand" must have been overlooked (see vol. i., p. 396): "On questioning the natives, as I usually did, relative to the natural history of their country, I heard a curious tradition connected with a totara-tree in the neighbourhood [Rotorua?]. Near this tree they said their forefathers killed the last moa. From the few remains of the moa that have been found it has been declared by Mr. Richard Owen to be a struthious bird of large size."

This story was told to Dieffenbach between the years 1839–41, and he most likely did not know Professor Owen's decision, given 12th November, 1839, until he returned to England—that is, some time after he had noted this story of the last moa killed in the north of New Zealand by the Maori.

Surely this authentic story is above the suspicion of the stereotyped assertion "that the Maoris invented it to suit the occasion." Further, it is remarkable that in other mention by the Maori of this bird to Dieffenbach it is a monster still to be met with, and seemingly more likely to kill men than to suffer itself in an encounter. You will see the justice of assuming that this is a story of the killing of the last moa by the Maori, and not as proving that the Maori said it was the last living moa at that time. It was the last that they themselves had killed, and the Maori, even in 1840, thought that the moa was still to be met with in out-of-the-way places, such as the higher parts of Mount Egmont, and other unexplored or *tapu* places.

Addendum.

Possibly the following might be the correct derivation of the word *ngarara* when used to denote the *Dinornis*. The prefix *nga* is the plural article of *te*, the—as for example, *te manu*, the bird; *he manu*, a bird; *nga manu*, birds. So, *te rara*, the roar; *he rara*, a roar; *nga rara*, much or many roarings—*i.e.*, the one of many roarings, or loud cries. In the South Island dialect the plural article *nga* becomes *ka*, which change is also shown in *ngarara-hua-rau* and *karara-hua-rau*, the name of a monster of mythical fame killed by Ruru-teina and his brothers when returning home with his bride. This name might therefore be rendered "the one who loudly calls his numerous progeny."

In verbs we have the following examples: *whà*, to be revealed; *ko-whà*, *tawhà*, and *nga-whà*, to burst open; and *nga*, used as a suffix to the obsolete word *kara*, to call—which is probably a variant of *rara*—in *kara-nga*, to shout.

I feel certain that the record of killing different taniwhas, each one with its own particular name or verbal definition, is founded on actual fact, and so far is historically true, but that, owing to the Maori having no written records of the past, but of necessity having to repeat each story from father to son by word of mouth, and the original standard or model of the creature spoken of having thereby become obscured or lost sight of,—having long ceased to exist,—the present ridiculous and mythical monsters have been evolved—creatures made, added to, and embellished by each succeeding narrator, till nothing of truth remains but the name of the doer of the deed, or the chief director, and the name of the place where the deed was accomplished.

Art. XXX.—*The Kea* (Nestor notabilis), *a Sheep-eating Parrot.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 8th October, 1894.*]

I have been prompted to write this paper on receipt of a letter from Mr. Alfred R. Wallace, F.R.S., who still holds to the old-time stories given of this bird long ago, and follows the lead of those who had but a second-hand knowledge of this bird, and so falls into errors, such as its leaving the berries of the forest-trees and taking to picking the kidney-fat out of live sheep running on the mountain-side, and being gradually trained thereto by commencing to sample the carcases of sheep hanging on the gallows or slaughter-place of the sheep-farmer. I am merely quoting from memory, and so am liable to vary the exact words. But I remember being astonished on reading of the kea living in the forest, for I never even during the severest winters saw it perched on a tree, and, further, the small patches of trees in the alpine valleys are all of one kind, a species of *Fagus*, which were called by the settlers black-birch. The fruit or "beach mast" of these trees is very minute and rare, and of little, if any, service to the birds of other species.

I have during hard winters tamed the kaka (*Nestor meridionalis*), which in a starved condition might settle on the house, when I would approach with a piece of raw meat on the point of a long stick, like a fishing-rod, but never a kea; and the only birds I remember picking at the carcases of sheep on the gallows were flocks of the newly-arrived bird, the small

white-eye, *Zosterops*, which came to New Zealand about the year 1860 as well as I can fix the date.

The berries on the ranges or mountain-side were few and of little food-value, the chief in point of size being the snow-berry, but it was seldom seen. My opinion is that the kea lived mainly on the lichen growing on the rocks and on grubs when obtainable. The lichen would, in places where the rocks were steep, be free from a covering of snow when all else was snowed up to a depth of 3ft. or more.

The kea always lived high up the mountains a long distance above the forest-line, for you must understand that on a mountain-side each variety of tree has its limit of elevation. The mixed bush grows on the plain; and a short distance above, where these trees, as rimu, white-pine, black-pine, &c., are at their highest, and cease to grow, come the different kinds of *Fagus*, of which the so-called black-birch attains the highest elevation. On glancing along the alpine hills, such as, for instance, those on either shore of Lake Wakatipu, you will see with surprise that the dark-green of the trees reaches so far up the mountain-side, and is then cut off level and clean as far as the eyesight can extend into the far distance. Above this level line of dark forest comes the brown straw-colour of the mountain-grass, which in turn gives way to the slate-grey or yellow-grey of the rocky summits and their *débris* of broken stones.

On this same forest limit grew also the tall bracken fern, so the dark-green of the forest would be at places for a considerable extent varied by the brighter green of the fern. But both forest and fern attained the same elevations, and so the long line of green was only changed in shade of colour, and did not encroach upon the area of the yellow grasses.* The kea lived above this forest limit, and was mostly seen moving about the rocks and boulders on the ridge of the mountain-tops. The name "kea" would seem to be an imitation of a frequent call of this bird. But it also makes a number of other sounds. About the first I can remember of this bird was at a time when I resided near the head-waters of the Oreti or New River. One hot day—it probably was in the summer-time—when walking across the valley between the mountains, my attention was attracted by a remarkable sound or series of cries. These I mistook for the noise of several small puppies of the wild dog, crying from hunger in the nest. I at once set to work to climb up the steep mountain-side to capture these creatures; but the result was not as was expected, but a dull-green-coloured bird was found seated on a projecting piece of rock. These birds are coloured green, shaded with black, and

* This description is of scenery some thirty years ago.

have bright orange-red feathers of small size on the underside of their wings. They are about the size of a kaka, rather narrower across the back, and have the hooked point of the upper mandible somewhat longer. Their feet are of the true parrot form, or, as a sailor would say, have the toes placed "fore and aft."

On first becoming acquainted with man they showed little sign of fear. In fact, I have, when on the mountain-top, remained standing perfectly still, with keas hopping round me, but would have ultimately to drive them away, for one would come to inspect the brass eyelets in my boots, and try to pick them out, when, seeing that the boot-laces would quickly be cut through, I would require to stop this performance. One day a shepherd brought home a live kea which he caught by placing his open hand on the ground when he was lying down; this bird calmly stepped on to his hand, and was captured. On bringing the bird home he placed it in a room in a stone building to await my coming. The result was that the small wooden bars of the window were cut away by its powerful beak down level with the panes of glass. A ring and small chain were afterwards fastened to its leg and it was tethered on the lawn, having a small box placed near as a shelter. Here it lived several years, but one day was missing, taking the chain with it. The shelter-box was soon a sight to see, for the bird drilled large round holes through it in several places, and his great delight appeared to be in carpentry work. He was fed on scraps of bread and meat, and would amuse himself by throwing his drinking-vessel away, regardless of after-consequences. Under the name of Sancho he was regarded as a member of our family party, but never gave any sign of newly-acquired habits under domestication, or showed signs of affection to those who cared for him.

About the year 1861 we first took sheep into this country, previously having stocked with cattle. The sheep increased and multiplied, and did remarkably well, notwithstanding the heavy snowfalls on the higher lands. After a number of years, when sheep were mustered in from the back ranges, it was noticed that several would die in the yards during the night, for they would require to be kept in for drafting on the following day. These dead sheep would be mostly sheep which had missed a shearing, and were double-fleeced, having very long wool. On taking the skin from these sheep a small hole, not previously seen, would be found over the shoulder-blades, or in the small of the back, over the kidneys. We were quite incapable of understanding the cause of these wounds, but considered that these sheep would not have died from the wound if it had not been for the heating they received from the drive of the muster. One day my brother

John came home and said that he now knew what caused the holes in the back of the sheep: it was done by the kea. This surprised me greatly, but I soon afterwards had evidence of the fact myself, for when some of these birds had once found out that the blood of the sheep was good for food others were soon initiated into the performance. It was seen that the sheep (merinoes) with the longest wool were those which chiefly suffered, from which I concluded that the length of wool gave the bird better facilities for holding on with his feet during the time occupied in drilling a hole into the unfortunate sheep, which would at first run madly about with the bird fixed to its back. Those sheep which were penned in by a recent fall of snow would be an easy prey.

A person living in this district brought some fifteen hundred crossbred cheviot and merino, and wintered them on these hills, but the extra length of wool on these sheep caused them to be specially attacked by the kea, and on mustering in the spring very few of this flock were found alive. Mr. W. M. Hodgkins, of Dunedin, obtained for me two brace of old-fashioned horse-pistols, which we would take with us when shepherding, loading with shot, and so peppering the keas; for to carry a gun was a heavy load when climbing about. The birds soon found out that we were enemies, and, in place of a friendly interview, were mostly seen flying about, screaming, far away on the opposite range. It became quite a rare thing to get within shooting-distance of these treacherous birds, and all our friendly interest in them was turned to murderous thoughts. I do not think they went specially for the kidney-fat of the sheep, or had any particular choice, but that that point was chiefly selected owing to the bird having a better hold when in that position. They would nest in the crevices of the rocks, but I never was able to take either eggs or young birds, the fissures being too deep and narrow to admit of approach.

Mr. Wallace asks me, did the kea mistake the live sheep for the vegetable sheep—a peculiar growth of lichen? I would say not, for I have never to my knowledge seen a vegetable sheep, or mistaken such for a living one, as the story goes. Therefore my particular keas were not likely to see this vegetable substance either; and I never knew the bird to be seen feeding on a dead sheep. The sheep always died after the repast, and were then left to the wekas (*Ocydromus australis*) and buzzard hawks, who would finish the work of destruction.

About the time at which we found out that the kea molested the sheep, we read in the papers that the shepherds on the Wanaka Station, some thirty or forty miles in a northerly direction from our position, had also discovered the same fact, and this made the authorities of the Dunedin

Museum very desirous to obtain a specimen of this bird. My brother John saved the skin of one and presented it to the Museum, and this was the first specimen down there. I can suggest no reason for the kea acquiring this new habit other than that the sheep, in winter-time, which were snowed in on the shady side of the range, would have a coating of snow or frost, and sometimes had long icicles hanging to their wool, so much so that the discoloured snowtracks of the sheep would be more readily seen by the shepherd than the sheep themselves, and from this disguisement of the sheep they might be more readily inquired into by the kea, who might mistake the frozen wool for a snow-covered piece of rock; but on the other hand the bird did not attempt to pluck the wool from the whole length of the sheep's back, as if in search of buried insects, but confined its operations to the one small area, either behind the shoulders or over the kidneys. Nor did the bird specially desire kidney-fat, which it seldom reached. It was the position and hold of the bird which determined the point of attack, for probably if the bird seated itself on the head or rump of the animal it would have been successfully driven away. A sheep would have great difficulty to turn its head or neck sufficiently backward to dislodge anything seated on its back immediately behind the shoulders. I would say that blood rather than flesh was what the bird desired, for, as said previously, no carcase was ever eaten, though the birds might be flying round in scores. The dead bodies, if touched at all, were eaten by the weka, the hawk, and the rat. I have even known the rat to nibble the tender hoofs from the living, new-born lamb; after a time, if the lamb survived, the hoof would grow down as would a person's finger-nail, and so the damage would be rectified. My knowledge of the kea has no reference to its habits at the present time, for I have for twenty years lived in a district where they are not to be found. As my excuse for writing this I append a copy of that portion of Mr. Wallace's letter which induced me to think it desirable that the habits of the kea should be remarked upon:—

Dear Sir,— Parkstone, Dorset, 3rd January, 1894.

I received from a friend of yours a number of the "Journal of Science," containing among other things some remarks on the habits of the kea. As the writer says that I have given "what is generally believed to be a correct description of the bird's habits, &c.," it will be time enough to change it when other New Zealand authorities accept Mr. Huddleston's account.

I see in another article it is stated that the habit of tearing open the vegetable sheep for insects led to the kea's tearing open first dead sheep and then living ones. . . .

Yours very faithfully,

Taylor White, Esq. Alfred R. Wallace.

To this I reply that Mr. Huddleston's article on the kea is the best I have seen on the subject, and, so far as my own experience goes, is reliable, and for this reason I specially obtained that number of the "Journal of Science" which contained Mr. Huddleston's paper, and forwarded it to Mr. Wallace: hence his letter to me thereon.

It must be remembered that this bird, having for its habitat the tops of alpine ranges, is seen by few other than shepherds and owners of sheep who are hardy enough to head the sheep-mustering parties, and whose business it is to search the rocky mountain-tops in summer for sheep requiring to be shorn or docked, and in winter, about the end of June, to collect, extricate, and drive downward sheep from the then heavily snow-clad summits. An account of this latter dangerous work I gave in a back volume of Transactions. Such are the men who can give the life-history of the kea, and of these I claim to have been one. But such doings are now a matter of retrospection.

Since writing the above I have been able to place my hand on Mr. F. F. C. Huddleston's paper. The passage in "Darwinism" to which he takes exception is the following: "It [the kea] belongs to the family of brush-tongued parrots, and naturally feeds on the honey of flowers and the insects which frequent them, together with such fruits or berries as are found in the region. Till quite recently this composed its whole diet, but since the country it inhabits has been occupied by Europeans it has developed a taste for a carnivorous diet, with alarming results. It began by picking the sheepskins hung out to dry, or the meat in the process of being cured. About 1868 it was first observed to attack living sheep, which had frequently been found with raw and bleeding wounds on their backs. Since then it is stated that the bird actually burrows into the living sheep, eating its way down to the kidneys, which form its special delicacy."

Mr. Huddleston says,—

"The reason, I believe, that the bird has been charged with eating the kidney of the sheep it attacks is that the loin or rump of the sheep is the broadest part whereon it can get an easy grip. As the sheep feels its assailant it runs away, with the bird holding on and naturally having its beak over the kidneys, where it sets to work. . . . I have found large numbers of sheep with only a very small hole in the back, about the size of a crown, which being examined showed a cavity beneath as large as a man's hand, in which the backbone and ribs were perfectly bare. Others I found with holes in the side through which the intestines had been drawn, the sheep being still alive, and in some instances the wound had healed and apparently formed

a false anus." (An instance of a wound healing as described I have witnessed myself—an opening in the flank. —T. W.)

"Besides grubs, as the weta (*Deinacrida*) and the *Cicada*, they feed on the berries of various alpine shrubs and trees [? T. W.], such as the snowberry (*Gaultheria*), *Coprosma*, *Panax*, and the little black seed in a white skin of the *Phyllocladus alpinus;* the *Pittosporum*, with its hard seed in a glutinous mass like birdlime; and the red berry of the *Podocarpus;* also, in winter, on the roots of the various herbaceous alpine plants—*Aciphylla squarrosa* and *colensoi*, *Ranunculus lyallii*, *Celmisias*, &c.

"About Mount Cook they breed very early in the year, as I have found their nests in August, when snow was on the ground. The first time that I saw nests at that time of the year was when I was shooting, at an altitude of 3,000ft. I shot a bird that was sitting on a rock. After it fell another appeared on the rock, and from the same place I shot twenty-two. I went to pick up the dead birds, and then found that they had, in the first place, all come out of a hole under the rock. On looking into the hole I saw something moving, which eventually turned out to be young birds. They were out of reach, but after some trouble I managed to noose one, and found that it was in its nesting plumage of slate-coloured down, with very yellow beak and legs. There were others in different stages of growth, also eggs. I have since found other nests, and have noticed that after a time the old birds leave the half-grown ones to hatch out the late eggs, all the community doing their share of feeding the young. The same habit I have noticed in the native parrakeet. The kea's egg is white, and about the size of a pigeon's, but rounder, and with a rough shell. The young birds do not come out of the nest until fully fledged and able to fly. The young birds are so tame that if a person comes across a flock of them and keeps perfectly still they will walk up to him and pull his clothes.

"I am unable to give a correct estimate of the number killed in the Mount Cook and Lake Wakatipu districts. The slaughter of them at times has been very great. At Lake Wanaka, in four years, I myself killed over three thousand, and I know of several up-country stations where one to two hundred were killed yearly. To reduce their numbers the County Councils used to give from 1s. to 2s. per beak, and the Government then gave the Councils a subsidy of pound for pound. This has now been discontinued, and so gives a chance of increase."*

* "New Zealand Journal of Science," September, 1891.

As quoted above, Mr. Huddeston speaks of the kea eating the berries of various alpine shrubs and trees, among others *Panax* and *Pittosporum;* these are only the taller undergrowth of the forest, or at times a few may be found in a warm gully alongside a small creek. They are all tall shrubs, and I have never seen them growing at the elevation frequented by the kea, but I have no knowledge of the vegetation about Mount Cook. *Podocarpus* is the generic name of several forest-trees, as the black-pine and totara, and these grow in what are termed the mixed bushes of the lowlands. I once found on a mountain-side, growing among and covering a large area of large, angular fragments of broken rocks, a peculiar prostrate shrub, and, after some search, found the seed or berry of this carpet-like growth. My sister made a coloured sketch of the small branch which I brought home. This I sent to Dr. Black, of Dunedin. He replied that he did not recognize it, and had handed the drawing to the care of the local Museum. At that time I had never seen the totara-tree of the forest (*Podocarpus totara*), but, on seeing a twig and fruit of this tree, I at once saw that my prostrate shrub was a variety of the totara. I hardly think Mr. Huddleston alludes to this variety of *Podocarpus*, and should be surprised to hear that the kea really has access to the fruit of any of the forest *Podocarpi*.

In this same journal Mr. F. R. Chapman, in describing a botanical expedition which he made to a valley of the Upper Waimakariri, Canterbury, says, "A very interesting *Raoulia*, or vegetable sheep, was very plentiful on steep, rocky places, but I believe a finer species is found on Mount Torlesse. . . . It is said that the keas tear them up with their powerful beaks, and that these birds learnt to eat mutton through mistaking dead sheep for masses of *Raoulia*."

Mr. Huddleston has, to my thinking, made a hasty guess as to keas' bill-of-fare, including *Coprosma*, *Panax*, *Pittosporum*, and *Podocarpus*. Also, I would ask, how could the bird feed in winter on the roots of *Aciphylla*, *Ranunculus*, or *Celmisia*, which would then be covered with a deep winding-sheet of snow 3ft. to 10ft. in thickness?

Art. XXXI.—*On the Abundance of* Vanessa itea *in Wellington during Season 1894.*

By Walter P. Cohen.

[*Read before the Wellington Philosophical Society, 27th June, 1894.*]

Last season a friend of mine who is a semi-entomologist, not now collecting, told me he had chased on one or two occasions in the Bolton Street cemetery, and also in the Botanical Gardens, a brilliantly-marked butterfly, which he said was not *V. gonerilla*, and which I could not identify from his description owing to his not having captured one to show me. I have therefore been on the look-out for something new in consequence, and was rewarded on the 3rd March this year by seeing a handsome butterfly settle on one of the paths in the cemetery when I was there in quest of sport, but, as it was a windy afternoon, and not having a net with me, I failed to catch it, so made two trips next morning, and saw none, but in the afternoon saw and obtained two specimens, which proved to be *V. itea*. I could have taken more, but it was Sunday, and lots of people were passing by the spot, which frightened my friends away. Since then I have taken up to date fourteen specimens at the same spot, as it seems to settle generally on the trunk of a large weeping willow (*Aspidiotus camillæ*), in company with *V. gonerilla*, which has always been very plentiful in this cemetery. *V. itea* flies as high as its sister, but is not quite so rapid in its flight, so is easier to capture, and, if frightened by a noise or anything coming near it, it always returns to the same spot shortly after. I exhibit this evening some of the specimens, and in one or two the large splashes on the upper wings appear to be of a much paler yellow.

I am inclined to believe that this handsome insect may have been imported here lately, as it is mostly a northern species, as I have two specimens which came from the Auckland District: these show the same markings. My co-worker, Mr. A. Norris, has taken it in Thorndon this summer, and it has been seen in Wadestown this season. Mr. G. H. Grapes, of Paraparaumu, saw it up there in January, 1892, and in 1893, when it was tolerably plentiful, but has only seen it once since. He netted his specimens on the flowers of the koromiko, marigold, sage, &c., and says it appears there from January to November, and with an interval midway between those periods; therefore my specimens must be of the autumnal brood, so I should like to know whether they hibernate or are double brooded.

Art. XXXII.—*A Chapter in the History of the Warfare against Insect-pests.*

By W. M. Maskell.

[*Read before the Wellington Philosophical Society, 11th July, 1894.*]

Members of this Society will recollect how often I have brought under their notice the procedure of the Americans and other people for fighting the various pests which injure crops or trees; and it may be thought perhaps that enough has been said on the subject. At the risk, however, of being wearisome, I venture again to draw attention to this matter, and to add another chapter to its history. The plans and methods of mechanical treatment which have been so extensively tried in different countries are, of course, still in use, and doubtless they are in many cases quite successful: indeed, I suppose that the culture of the vine and the orange would be exceedingly difficult and precarious unless these methods were actively pursued. The New Zealand cultivator, as a rule, does not care to attempt anything systematic or properly organized, except, indeed, that every now and then he gets into a terrible fright and scare, and runs wildly to the Government praying for drastic and repressive legislation, which, if he obtained it, would probably be useless. Elsewhere, especially in America, they manage differently, and combination and co-operation are frequently successful, while in this country the disorganized efforts of a few individuals are mostly futile. But in any case it seems to be rapidly becoming understood that, whatever may be the value of mechanical methods against pests, the best process to be adopted is the introduction of the "natural enemy," and its very careful culture and propagation when once introduced. I will not now inflict again on the Society the well-worn history of *Vedalia* and *Icerya*. Everybody here, I presume, knows that pretty well. But the last chapter of that history laid before the members ended with the second journey of Mr. Koebele to Australia, and his introduction from thence into California of several parasitic insects designed to destroy various other scale-blights in that country: a procedure which, as I am given to understand, has been so far successful already as to have helped greatly the eradication of such pests as *Lecanium oleæ* and *Mytilaspis pomorum*.

Later on Mr. Koebele was engaged by the people of the Sandwich Islands to undertake a similar work for them. These islands are excellently adapted for the cultivation of oranges, lemons, and other fruit, and a large trade could be

carried on in them if the insect-pests were kept down—as also in coffee, which is now largely planted there. Already, before Mr. Koebele's engagement, the planters had been troubled with *Icerya purchasi*, and I may pause here a moment to give you what may perhaps seem an even startling statement. In the year 1891, I think, Mr. Jaeger, a resident of Honolulu, wrote to me saying that *Icerya* was rapidly increasing there, and asking me to procure for him some *Vedalia* to eat it. Although I could not myself supply him, I was able to put him in the way of getting these useful beetles, and in a few months he introduced them to Honolulu. By that time, however, *Icerya* had enormously increased there, so much so that, in a letter received by me only a week or two ago, I find this statement: "*Icerya* became so numerous that it was not safe to walk in the streets, as they became so slippery; and near a large burying-ground, where the 'monkey-pot trees' were full of the scale, on the side where the wind blew towards some houses the people had to leave the houses because they became so full of the young insects that it was impossible to sleep." After the introduction of *Vedalia*, Mr. Jaeger says, in six months a clean sweep was made of *Icerya*, the ladybirds increasing in such numbers that in places they could be swept up in heaps; and now the Sandwich Islands have no more to fear from *Icerya*.

Encouraged by this success, the people of Hawaii thought they might extend their efforts, and they engaged Mr. Koebele to give them his time and energies with this object. Going to Honolulu in 1892, he sent down to me several scale-insects for identification and description; and I was able to put him on the track of some useful parasites by acquainting him with the native country of some of these pests and their relationships and life-histories, for particulars of this kind are great helps in that direction. Some of the scales in question were described or mentioned by me in my paper of 1892 (Transactions, vol. xxv.), and others will be included in my paper for the volume of 1894. Amongst them are two especially injurious ones, which I have named respectively *Pulvinaria psidii* (on guava and coffee) and *Dactylopius vastator* (on orange and a great many other trees). Both of these are probably importations to Honolulu from Japan in the last five years. Regarding the first, Mr. Koebele, who is at present in Australia, writes to me that it "attacks the coffee, and bad at that; and for miles away you could see the presence of the scales by the black appearance of the guava forests." As to the second, he says, "I have seen no Coccid that is so destructive to trees as this species." But he goes on to say, "I have already introduced two of the ladybirds which prey on *Pulvinaria psidii*, and think that in a couple of years it will be rare in Hawaii;

and, as for *Dactylopius vastator*, I trust the danger is over, as we have already sent several colonies of its enemies."

When the late Agricultural Conference was sitting here I endeavoured to bring this question of scale parasites before it, and I understand that a resolution was again passed asking the Government to appoint "an entomologist." In Auckland lately a similar conference passed a similar resolution; but there they went further, and suggested that a certain gentleman should be so appointed. I have not the least desire to make any ungracious remarks, nor have I a word to say against that gentleman as an entomologist, but it is my duty to repeat what I said three or four years ago in my memorandum to the Minister of Lands: there is not in New Zealand an entomologist of the kind required for this purpose. Either the thing is worth doing properly or it is not worth doing at all. The Hawaiian people think it worth their while, and they import a trained expert. Their example should be a lesson for New Zealand.

I regret very much to inform the Society that the leading economic entomologist of the world, Dr. C. V. Riley, of Washington, has lately been obliged, from ill-health and other causes, to resign the position of head of the United States Agricultural Department in that branch. Dr. Riley is one of the honorary members of the New Zealand Institute. Farmers and cultivators of every kind in every country of the globe owe him a great debt of gratitude for what he has done for them in the last thirty years, and I am sure that this Society, although not personally acquainted with him, will join with me in feeling deep regret that the official services of so ardent a friend to all agriculturists should for the future be lost to the world.

Art. XXXIII.—*On the Anatomy of Flight of certain Birds.*

By Sir James Hector, F.R.S.

[*Read before the Wellington Philosophical Society, 25th July, 1894.*]

The mechanism of the flight of birds is an attractive subject, and its various modifications afford some of the strongest arguments in favour of the views of those who hold that the structure of animals is wonderfully plastic. It is beyond doubt that the outward form and even the internal structure of birds changes readily under the constraint of changing environment and function, as, for instance, in domestic poultry. I have recently made two observations which may be worthy of record, as throwing further light on this subject.

1. THE ANTIPODES PARRAKEET (*Pezoporus fairchildii*).

A comparison has been made of the structure of the sternum and scapular appendages with those of the red-topped parrakeet, which is also found in the Antipodes Island, but is conjectured to have been a more recent introduction. The anatomical peculiarities bear out this view. In the New Zealand form, which is smaller in size, the sternum has a larger keel, but the marginal area external to the supporting ridge is largely developed, while in the Antipodes Island form this marginal area is almost wanting. On the other hand, the body of the sternum is more massive, broader, and more complete than in the New Zealand red-topped *Platycercus*, the large foramina being almost obliterated. The shape and angle of articulation of the acromions and scapulæ are the same in both, but there is a marked difference in the representative of the clavicles. The true furculum formed by the thorough anchylosis of the clavicles in the mesial plane is well known to be totally absent in *Platycercus* and its allies, but it is represented in some forms, such as *Pezoporus*, or the ground-parrakeet of Australia, by a band of fibrous tissue that braces the sternum to the distal extremity of the coracoid, thus supporting the articulation of the wing. It thus performs one function of the furculum, but not its chief function, which is that of a powerful spring, reacting against the downward stroke of the wing in powerful flight.

Now, in the Antipodes Island parrakeet there is a marked development of the fibrous bond between the sternum and the coraco-humeral articulation, and, following in the same direction, we find in the kakapo (*Stringops habroptilus*), which is a parrot without proper flight, that the keel of the sternum is almost obliterated, while the fibrous sterno-coracoid has been enormously developed and ossified, so that it forms a wide bony process, which on each side is attached to the sternum. If, as is probable, and has always hitherto been accepted, these processes represent clavicles, then it must be conceded that this clavico-sternal form of articulation more resembles that of animals which use the fore-limb for progression by thrust rather than by flight.

If this view be correct, there is good ground for supposing that the Antipodes Island parrakeet is an ancient form which has in some degree lost its power of flight, and has degenerated toward the condition of the kakapo.

2. WING-BONES OF THE ALBATROS.

The means by which the albatros maintains its remarkable flight for long periods and at all various angles to the wind without any apparent recovery of its initial velocity by the flapping of its wings has been the subject of much contro-

versy. It has always appeared to me that it might not be altogether a subject in the domain of mathematical physics, as has been assumed, but rather that it might be a difficulty for the anatomist to solve with his scalpel. In 1871 I made some attempts, assisted by my friend Sir Walter Buller, to dissect, after injecting the arteries and veins, the wing of the albatros; conjecturing that, as such birds are rarely obtained in the flesh in the Northern Hemisphere, some structural differences might have escaped notice. We were not very successful on that occasion, excepting that I believe we discovered that the long tendon extending from the extensor muscles that control the folding-up and expansion of the wing (*extensor plica alaris*) terminated in tendinous fibres which, supplemented by muscular fibres, grasped the quills of the large pinion-feathers, and might perhaps impart to them a reciprocal motion like the feathering of an oar.

It was difficult to conceive how these muscles could perform two such difficult functions as were involved in the expansion of the wings as a whole and at the same time to exercise a control over its distal appendages. I was therefore not surprised when the result of the dissection of several fine specimens in the flesh preserved in spirit, and which I submitted through Sir Walter Buller to authorities in London, pronounced against there being any anatomical structure present.

Lately I have had an opportunity of re-examining the wing of a large albatros in the flesh, and find the following peculiarities, which, so far as I know, have not been hitherto recorded: The extensor muscular tendon, instead of being attached as in other birds only to a fixed process at the distal extremity of the humerus, is also attached by a subsidiary offset to a projecting patelloid bone which is articulated with the process, and thence proceeds to the radial carpal bone, and thence onward along the radial aspect of the manus, where it expands into fibrillæ that embrace the quills. When the wing is fully extended the thrust of this projecting process on the elbow-joint causes a slight rotation of the ulna on the humerus, so that the joint becomes locked, which renders the wing a rigid rod as far as the wrist-joint. At the same time the slight play permitted by the articulation of the patelloid bone on the process allows of the transmission of the muscular pull from the shoulder to the manus without unlocking the joint. By this mechanism the sustaining diameter of the bird is enormously increased without any increase of weight. In an albatros of ordinary size the rigid surface presented to the atmosphere like a parachute would have an extension of 10ft. Beyond this on either side is the true efficient pinion of the bird, erroneously called the tip of the wing, which, as all who have

closely watched the flight of this wonderful bird know, is ever in motion, sometimes flapping on the surface of the sea as it dips to a wave, or elevated as it turns in the force of the gale, and, though no doubt difficult to observe, it is in constant quiver of slight rotation of the broad plumes, opening and closing like Venetian blinds. We have in the mechanism thus described a sufficient source to sustain the prolonged, and to the casual observer apparently effortless, flight of the albatros. The locking of the elbow-joint in the albatros is exactly analogous to the locking of the knee-joint of the human skeleton by which man maintains without fatigue that erect attitude which proclaims his supremacy.

It is very much to the point that the only other bird which posseses a patelloid bone controlling the elbow-joint as the patella does the knee-joint is the penguin, and in this case the wing-bones have also to be kept rigid during the penguin's flight under the water.

Art. XXXIV.—*Further Contribution to a Knowledge of the New Zealand Sponges.*

By H. B. Kirk, M.A.

[*Read before the Wellington Philosophical Society, 28th November, 1894.*]

Plates XXIV.–XXVI.

In my former paper on New Zealand sponges I expressed an intention of describing the New Zealand sponges in something like their natural order. I think it best, however, to describe at once the two very interesting sponges that form the subject of this paper. I also abandon the intention of copying, except in rare instances, the descriptions of New Zealand sponges already published.

Sycon dendyi, n. sp. Plate XXIV.

The genus *Sycon* is thus defined in Dr. Dendy's "Synopsis of the Australian Calcarea Heterocœla": Sycettidæ with "radial chambers not inter-communicating; articulate tubar skeleton; the distal ends of the chambers provided each with a tuft of oxeote spicules."

The definition above given, taken with that of the family Sycettidæ, did not contemplate the inclusion of such a sponge as forms the subject of this paper—a sponge that has a well-developed cortical skeleton of large oxea, through which the

distal cones protrude. This sponge forms a most interesting link between the two genera *Sycon* and *Ute*. In spite of its striking peculiarity, I think it better to place it in *Sycon*, from which received definitions do not exclude it, than to establish a new genus.

The sponge is solitary, or forms small clusters. It is about 20mm. in height and 7mm. in breadth. There is a well-developed gastral cavity and a short peristome. There is a dermal cortex containing several layers of large oxeote spicules, longitudinally disposed, and it is pierced by the projecting distal cones of the radial chambers. The tubar skeleton consists of sagittal 3-radiate spicules, and the well-developed gastral cortex consists of 3-radiates and 4-radiates, the apical rays of the latter projecting into the gastral cavity in the usual way.

Spicules :—

Oxea of dermal cortex : These are very large fusiform spicules, tapering to moderately sharp points. 1·18mm. × 0·06mm.

Oxea of peristome : Thickest near the proximal end ; sharp-pointed. 0·25mm. × 0·01mm.

Oxea of distal cones : Thickest part about one-third of the distance from the proximal end. 0·11mm. × 0·01mm.

Triradiates of chamber-layer : Sagittal ; sometimes irregular. The basal ray is generally longest in the spicules that immediately underlie the gastral cortex. Greatest size of basal ray, 0·23mm. × 0 018mm. ; of oral rays, 0·13mm. × 0·015mm. The oral rays generally curve away from the basal ray, which they leave at an angle of about 110°. Often one of the oral rays is shorter than the other. Sometimes the basal ray is shorter than either of the oral rays.

Quadriradiates of gastral cortex : Sagittal ; basal ray, 0·14mm. × 0·01mm. ; oral rays, 0·08mm. × 0·008mm. The rays taper evenly to a sharp point.

All the radial chambers have well-marked chamber diaphragms, the circular opening in which communicates with the short canal leading through the gastral cortex to the gastral cavity. The chambers are octagonal in transverse section ; the inter-canals quadrangular.

A specimen containing ova shows frequently two or three ova in one capsule—a rudimentary ovary.

Dr. Dendy has already pointed out (" Quarterly Journal of Microscopical Science," 1892, p. 168) that *Sycon gelatinosum* has a rudimentary pore-bearing membrane stretched between the distal cones, and that a similar membrane in *S. boomerang* contains a few spicules, showing the path by which the *Grantia* type has probably emerged from the *Sycon ;* but the

existence of the distal cones characteristic of *Sycon*, together with the longitudinally-disposed cortical oxea that mark *Ute*, has not hitherto been known.

This sponge shows striking and beautiful colour-changes at death. When living it is either white or dull-purple as a rule, but in dying it turns saffron-colour, red, and bright-purple.

Localities.—Cook Strait; Hokianga Heads.

Lamontia, new genus.

Grantidæ with spherical or polygonal flagellated chambers; skeleton of the chamber-layer consisting entirely of oxea; dermal cortex containing radiates.

Lamontia zona, n. sp. Plates XXV., XXVI.

Sponge solitary; oxea of chamber-layer small and curved; cortical skeleton of large 3-radiates, of small oxea like those of the chamber-layer, and of large projecting oxea and oxy-strongyla; gastral armature for the most part of small dagger-shaped 4-radiates, but of large 4-radiates near the oscule; peristome of long oxea with sagittal 3-radiates at the base on the inner side. A specialized pore-area is present, and this area is without any projecting oxea or oxy-strongyla.

This sponge is from 14mm. to 20mm. in height, and from 4mm. to 7mm. in breadth. The external armature of oxea does not appear at first sight to differ from that of many other leuconoid sponges, but the unarmed pore-area enables the sponge to be distinguished at a glance. This area is usually a little below the oscular opening, and in the best specimens it forms a regular zone of a dead-white colour. It may, however, in specimens more or less misshapen, be irregular in outline, and may even become a longitudinal strip. The groups of pores in this specialized area lead into well-marked chones, below which are well-developed subcortical chambers. Between the chones are columns and walls of superimposed 3-radiates, which support the pore-bearing membrane. The membrane contains small oxea exactly like those of the chamber-layer. I believe that the existence of a specialized pore-area is not known in any other calcareous sponge. Pores are not confined to the specialized area, but are scattered over the whole dermal surface. Beneath the cortex, in other parts of the sponge than below the pore-area, are subcortical lacunæ of irregular shape and varying size.

Spicules :—

(1.) Projecting oxea of dermal cortex: Very large, thickest near the proximal end, often of wavy outline; size may be as much as 0·9mm. × 0·051mm., or even greater.

(2.) Spined oxy-strongyle of dermal cortex: A beautiful spicule, not always easily found, but always present, and sometimes abundant. The spined portion is usually about one-quarter of the whole spicule, and terminates in the rounded, distal end. From this end the spicule tapers evenly to a sharp point. Measurement, 0·28mm. × 0·01mm.

(3.) Triradiates of dermal cortex: These are generally irregular or slightly sagittal, the oral rays in the latter case being slightly curved towards each other: the rays may be 0·35mm. × 0·035mm. They sometimes taper evenly to a point, but generally they taper more rapidly at the ends.

(4.) Oxea of cortex and parenchyma from 0·07mm. to 0·1mm. × from 0·005mm. to 0·01mm. The spicule is thicker at one end than at the other, and near this end it makes a well-marked bend. Towards the sharper end there is usually a curve in the opposite direction, the spicule having thus a slightly sigmoid outline.

(5.) Oxea of peristome: Long and thin spicules, thickest in the proximal portion. 1·5mm. × 0·015mm.

(6.) Triradiates of peristome: These are very graceful sagittal spicules. The basal ray is very slight and tapering, and may measure 0·45mm. × 0·008mm. The oral rays are flattened in the plane of the basal ray, from which ray they usually diverge at an angle of about 50°; they curve slightly inwards from the plane of the basal ray, and they may also curve very slightly upwards or downwards. The outline of the oral rays may be tapering or curving, the rays being often widest and flattest at about two-thirds of the distance from the point of origin. Measurement of oral rays, 0·15mm. × 0·015mm. These spicules are arranged with great regularity at the base of the peristome on the inner side, the basal ray directed downwards, and the oral rays spread across the lower parts of the oxea of the peristome. It may be noted that the gastral epithelial cells are well marked till just above these spicules, where a well-marked sphincter terminates the endodermal tissue.

(7.) Quadriradiates of gastral surface: Near the oscule the gastral surface shows large sagittal quadriradiates, which vary greatly. Generally the rays, which have a curving or wavy outline, have rather blunt points. Basal ray, 0·26mm. × 0·025mm.; oral rays, from 0·2mm. to 0·25mm. × 0·02mm.; apical ray, from 0·1mm. to 0·15mm. × 0·02mm. to 0·025mm. These spicules are not numerous.

The larger exhalent canals and the lower part of the gastral cavity are freely armed with small dagger-shaped 4-radiates, much like those of *Leucandra gladiator*, Dendy. The rays lie almost in the same plane. The basal ray is short and stout, 0·02mm. × 0·008mm. The oral rays, which are of about the

same length as the basal ray, or slightly shorter, curve towards the apical ray; or one may curve towards the apical and one towards the basal ray. The apical ray is comparatively long, 0·05mm.; it is generally slightly curved, and sharply pointed. Between these small dagger-shaped spicules and the large 3-radiates of the oscular region all stages in form and size may be found.

A peculiarity of this sponge is that the gastral cavity becomes almost entirely obliterated in adult specimens, the exhalent canals converging to open very near the osculе. In young specimens the gastral cavity is very well marked.

I am indebted to Dr. Dendy for pointing out clearly what I had, for my own part, only very indistinctly felt—that the parenchymal oxea of this sponge, so like in form to the "mortar spicules" of many calcareous sponges, are probably incursive from the dermal cortex, and replace original parenchymal radiates, just as in *Anamixilla*, Pol., the large parenchymal radiates are probably incursive. If this view is correct, *Lamontia* is especially interesting as showing how the characteristic skeleton of *Leucyssa* may have been derived from that of *Leucandra*.

Locality.—Cook Strait. The sponge is rare.

EXPLANATION OF PLATES XXIV.–XXVI.

Plate XXIV.

Sycon dendyi.

Fig. 1. A group of individuals, natural size.
Fig. 2. Portion of dermal surface: *c*, distal cones; *o*, dermal oxea; *p*, pore.
Fig. 3. Longitudinal section: *r.c.*, radial chamber; *d*, chamber diaphragm; *o*, dermal oxea; *c*, distal cone.
Fig. 4. Transverse section: *i*, inter-canal.
Fig. 5. Section across tubes and inter-canals: *r.c.*, radial chamber; *i*, inter-canal.
Fig. 6. A prosopyle, surrounded by collared cells.
Fig. 7. Unsegmented ovum.
Fig. 8. Ovum subdivided: *c.c.*, collared cells; *e.c.*, endothelial cells.
Fig. 9. Three segmented ova in a common capsule (the ovum on the right was damaged, and I have not shown it in section): *c.c.*, collared cells; *e.c.*, endothelial cells.
Fig. 10. Longitudinal oxea of dermal surface.
Fig. 11. Oxea of cones.
Fig. 12. Oxea of peristome.
Fig. 13. Sagittal 3-radiates of chamber-layer.
Fig. 14. Irregular 3-radiates of chamber-layer.
Fig. 15. 4-radiates from gastral cortex.
Fig. 16. Two collared cells, with flagellum retracted, and an amœboid cell.

PLATE XXV.

Lamontia zona.

Fig. 1. The sponge, natural size.
Fig. 2. Portion of pore-area, from below.
Fig. 3. A pore, with muscle (?) cells.
Fig. 4. Portion of base of peristome, with cells of sphincter.
Fig. 5. Section through pore-area: *ch.*, chone; *s.c.* subcortical crypt; *col.*, column of 3-radiates.
Fig. 6. Longitudinal section: *e.c.*, exhalent canals.
Fig. 7. „ *s.l.*, subcortical lacuna.
Fig. 8. Prosopyle and collared cells.

PLATE XXVI.

Lamontia zona.

Fig. 1. Parenchymal oxea.
Fig. 2. Large oxea of dermal cortex.
Fig. 3. Spined oxy-strongyla of dermal cortex.
Fig. 4. Oxea of peristome.
Fig. 5. *a–c*, 3-radiates from base of peristome.
Fig. 6. *a–d*, 3-radiates of dermal cortex.
Fig. 7. *a–f*, 4-radiates from neighbourhood of oscule.
Fig. 8. *a*, three "dagger" spicules from gastral surface.
b, „ „ *in situ*.

ART. XXXV.—*On a New Shell* (Anomia walteri).

By Sir JAMES HECTOR.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

SHELL fragile, nacreous, with brilliant lustre and translucent. Form irregular, the upper valve convex, corrugated, and often bullate. Structure lamellar, with faintly-marked wide ribs and wavy rays. On the interior surface a triangular area of white shell extends from the cartilage-pit to the middle of the valve, within which area are three distinct and equal-sized muscular scars. The cartilage-pit is single and straight, submarginal, and under a feebly-developed beak. The lower valve is horny and almost transparent, except an opaque white crescent round the notch. In form it is concave, and imbedded in the upper valve like an operculum. The notch is of a moderate size, with a strong anterior process which is hinged to the pit in the upper valve by a black ligament. The posterior margin is very thin. The shelly plug has not been preserved in any of the specimens. Colour: Upper valve rich honey-yellow, sometimes with pink tint; lower valve colourless.

Locality.—Pahia, Bay of Islands, Auckland.

A large number of specimens of this very beautiful shell were collected by Thomas Walter, Esq., to whom the species is dedicated. The same sea-beach is famous for the frequent occurrence of the rare and interesting shell *Murex angasi*.

Art. XXXVI.—*On some New Species of* Tipulæ (*Daddy-long-legs*) *found in New Zealand.*

By G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

The following five species of *Tipulæ* are here briefly described, as they are all large and conspicuous insects, and not at all likely to be confused with any other species. My knowledge of the Diptera generally is not yet sufficiently advanced to enable me to determine with certainty many of the other smaller or less distinct species which I have in my collection, and I shall therefore place these in abler hands as opportunity offers. I should here remark that it may, perhaps, subsequently prove necessary to remove some of the species here described into other genera, as my sources of information on the subject of the classification of Tipulidæ are necessarily somewhat imperfect. I do not think, however, that any trouble or inconvenience will result to future students of the order from this circumstance, as the species here characterized are some of the most striking and conspicuous insects we have in New Zealand.

1. **Tipula dux**, n.s.

Dark-brown; thorax with four more or less distinct darker stripes on the back and a shining white streak on each side beneath the wings. Abdomen dark-brown. Legs dark-brown, the articulations of the femora and tibia paler. Wings dark smoky-brown, the veins marked in darker brown; the surface of the wing considerably wrinkled in the vicinity of the costal and discoidal vein. There are several small transparent marks near the tip of the wings. Length of body of male 14 lines, of female 17 lines. Expanse of wings of male 28 lines, of female 30 lines.

This species may be immediately recognized by its very large size and dark coloration. It frequents damp situations in deep forest gullies, and is usually dislodged from the

overhanging banks of streams in December, January, and February. It is far the largest and handsomest species of *Tipula* we have in New Zealand. Wellington is the only locality I know of at present.

2. **Tipula rufa,** n.s.

Reddish-orange; thorax with a dark central band above. Wings bright reddish-orange; a black stripe from base to inner margin at about one-third, another fainter stripe from centre of wing to inner margin at two-thirds, and another dark stripe from costa at two-thirds to centre of wing, almost joining second-named stripe. Length of body 13 lines. Expanse of wings 19 lines.

At once distinguished by its brilliant orange colouring and large size. It appears to be a scarce species. I have only taken two specimens at present, both in rather dry situations in forest near Wellington. The insect also occurs in the neighbourhood of Nelson.

3. **Tipula orion,** n.s.

Body stout, very dark orange-brown, abdomen with a black dorsal stripe. Legs very stout, jet-black, bases of anterior femora orange. Wings pale-yellow, with veins darker (in one specimen), or dusky with black veins (in the other specimen); stigma and a broad marginal costal line jet-black in both specimens. Length of body 7 lines. Expanse of wings 18 lines.

Of this very handsome species I took one specimen on Mount Peel (near Nelson), at 4,000ft. above sea-level, and another on Mount Mathew, the other side of Wellington Harbour, at about 2,500ft. above sea-level. The two specimens are not exactly alike, but until more are found I think it preferable to regard them as constituting a single species which may be immediately known by the broad black costal stripe and black stigma.

4. **Tipula obscuripennis,** n.s.

Pale yellowish-brown. Sides of thorax and abdomen dark brownish-black. Legs pale yellowish-brown; in the female banded with dark-brown. Wings pale yellowish-brown, a brown spot on the costa at one-third, a broad oblique band nearly extending to inner margin at one-half, an interrupted curved series of spots at two-thirds; the terminations of the veins dotted with brown, and several minute brown dots near base of wing. Length of body 7 lines. Expanse of wings 14 lines.

An abundant species in forest, frequenting rather dry situations (Wellington).

5. **Tipula atropos**, n.s.

Body slender, dull-black, without markings. Legs very long and slender, dull-black. Wings rather broad, uniform smoky-black, the stigma a little darker, veins black. Length of body 5 lines. Expanse of wings 13 lines.

I took a single specimen of this insect hovering about in a cave at Terawhiti in December, and have seen others in similar situations. The species may be recognized by its extremely sombre and fragile appearance. It is possibly not a true *Tipula*

II. — BOTANY.

Art. XXXVII.—*The Algæ of New Zealand: their Characteristics and Distribution.*

By Robert M. Laing, B.Sc.

[*Presidential Address to the Philosophical Institute of Canterbury, 7th November, 1894.*]

No paper of a general kind about our seaweeds accessible to the ordinary reader has appeared since the publication of Hooker's "Handbook of the New Zealand Flora" in 1864. I have, therefore, thought that this would be a fitting opportunity to summarize some recent results, and to attempt to show the chief characteristics and affinities of the species inhabiting our shores. This, as you know, has already been done for our flowering plants, but no endeavour has been made as yet to compare our seaweeds with those of other botanical districts. Of course we cannot expect the broad generalizations from such a comparison that we get in the case of flowering plants, but I think the results, whether negative or positive, will be sufficient to justify the labour, particularly as the subject of the distribution of the marine Algæ has received considerable attention recently.

In Hooker's Handbook the number of species of marine Algæ described is 317, made up thus: *Chlorophyceæ*, &c., 40; *Rhodophyceæ*, 219; *Phæophyceæ*, 58. After the publication of this book no work was done among our seaweeds until in the early seventies Dr. Berggren, of Lund University, carefully collected them in all parts of the colony. His collections were handed over to the great algologist, Professor J. G. Agardh, who in 1877 published an annotated list of our species under the title *"De Algis Novæ Zealandiæ Marinis." In 1892 Professor Jeffery Parker, F.R.S., of Otago University, sent a small collection of New Zealand Algæ to Professor Harvey Gibson, of Liverpool. This collection is described in the "Journal of Botany," vol. xxxi., No. 366. No other work of a general character has, so far as I am aware, been done

* The specific names of this list have been adopted throughout the paper where no authority is given.

on our seaweeds since they were described by Harvey in the "Flora Novæ Zealandiæ."

Agardh's list is not quite complete, as it takes no note of Corallines, of which twelve are recorded in the Handbook. The total number of species included in it is only 277, or forty less than those given by Hooker. On the other hand, forty-four of the species included are new to our Islands; and, of these, thirty-nine are new to science, and consequently are, as far as we know, endemic; and three others—*Ceramium nodiferum*, *Gigartina laciniata*, and *Gracilaria flagellifera*—are only known from the Chathams, which appear to be richer than much of the neighbouring mainland in species. The two lists therefore include about 233 species in common. Agardh's list, on adding to it the Corallines of Harvey and Hooker, excludes about seventy-two of the species described in the Handbook. It is difficult to be positive about the exact number, as sometimes one species in one list will correspond in part to two or three in the other. Again, there must be added to Agardh's list two species—viz., *Ceramium stichidiosum*, *Asparagopsis armata*—omitted from it probably by an oversight, as they are admitted by him into our flora elsewhere.* However, after making these additions, the discrepancies between the two lists still remain rather large. Perhaps it would be well here to remind you of the following passage from Hooker's preface to the Algæ in the Handbook:† "To my late friend Dr. Harvey I am indebted for the determination and description of the New Zealand Algæ in my Flora of these islands. His widely and deeply deplored death during the present year has deprived me and this work of the benefits of his revisal of the following compilation."

It is quite possible that had Dr. Harvey lived some of the discrepancies between the lists referred to above would have disappeared—some of the species incorrectly included in the Handbook would probably have been excluded. Thus, for example, the well-known *Sargassum bacciferum*, or gulf-weed, appears in it on the authority of D'Urville, Lesson, and Sinclair. Its appearance is possibly due to the imperfect description of imperfect specimens. ‡*Turbinaria*, *Phyllospora*, and *Scaberia*, on the other hand, may have crept in on account of their occurrence in Australia. Early writers were not always careful to distinguish between Australia and Australasia. None of these genera have been found by any recent collector in New Zealand, and, as the species are all large and conspicuous, they would certainly have been obtained recently,

* "Epicrisis Systematis Algarum," p. 106 and p. 666.

† "Handbook of the New Zealand Flora," p. 639.

‡ *Vide* "Systematic and Structural Account of the Genus *Turbinaria*," by Miss E. S. Barton: Trans. Linn. Soc., Oct., 1891.

even if comparatively rare or sporadic, whereas both *Scaberia* and *Phyllospora* are stated to be common in the Handbook, although no precise locality is given. **Lessonia fuscescens* I have dealt with elsewhere. After excluding such intruders we find Agardh and Hooker in practical agreement as to our *Phæophyceæ*, which we may now say are comparatively well known. The chief points of difference still remaining are the introduction by Agardh of two previously unknown species of *Elachista* and four new *Cystophoræ*, making his list of *Phæophyceæ* fifty-three, while Hooker's stands at fifty-eight. Further alterations will no doubt be chiefly towards a better discrimination of species and varieties. This is wanted especially in the genera *Carpophyllum* and *Ecklonia*, and probably also in *Cystophora*.

On turning to the *Chlorophyceæ* we find thirty-seven in Hooker, of which, however, several belong to fresh water. Agardh has only twenty-four, and of these only two are new. He has rejected, therefore, about fifteen of Hooker's species. Of these, several are fresh-water plants; but on excluding these there still remain about eight species which do not occur in Agardh's list. These are either varieties of recognized forms or minute plants belonging to the lower orders. I have, however, seen several minute *Chlorophyceæ* which I could not assign to any of Agardh's species. It may be regarded as certain that some small green seaweeds still remain to be discovered. I have here, and throughout the paper, omitted the *Protophyceæ* from consideration, as they are but little known.

On turning to the *Rhodophyceæ*, we find the divergences existing between the two authorities are very numerous. Many of them of course are only differences of classification due to our increased knowledge of the methods of reproduction; many others are differences in synonyms; but when these are eliminated there still remain a large number to be accounted for. Thirty-five new species have been added by the recent writer. As the total number in his list is 195, on allowing for the Corallines we find he has evidently excluded about fifty of Hooker's species. Again, it may be remarked that it is difficult to give the exact number, as it is not always possible to trace the correspondence of specimens under different names, and as many of Agardh's identifications of Harvey's species are marked with a (?). It would not serve any useful purpose at present to investigate in detail the points of difference between them, as it would be impossible in many cases, without access to type specimens, to form an independent judgment about the point at issue. What I wish to do is to determine within what possible limits of error our

* Trans. N.Z. Inst., vol. xxvi., p. 304.

knowledge is reliable, so that in the succeeding portions of the paper no ill-considered generalizations may be indulged in.

Unfortunately, neither Harvey nor Agardh ever visited New Zealand, and consequently they have only seen our plants in the dried condition; but the latter, doubtless inheriting his father's rich collections, and having received duplicate types of most of the species described throughout the century, has had a far wider range of specimens to work upon than Harvey, who, however, had examined the Australian marine Algæ in the living condition during a stay of some months there. Agardh, again, has been for many a year, and still is, the chief living authority on the morphology of the Algæ, and his list undoubtedly represents a far closer approach to accuracy than that of the Handbook. It must be noted also that it is in no way a compilation, as the other was. He has only inserted in it a few species not collected by Dr. Berggren, and these upon the best authority. It may be fairly assumed, under these circumstances, that very nearly all of the species enumerated in it are genuine, and inhabitants of our shores. On the other hand, it is quite impossible to say how many of the fifty species excluded may again be found here. Against many of them the *primâ facie* evidence is strong. Amongst them are no less than eleven species of *Polysiphonia*. This is the largest and most difficult genus of *Rhodophyceæ* to discriminate, and there must always be much uncertainty as to the exact delimitation of its species. Another dozen have only been collected at the Auckland Islands, and the majority not at all since D'Urville's expedition. Taking all things into consideration, it is probably correct to assume that at least two-thirds of Agardh's "species excludendæ" have been rightly thrown out. On the other hand, we may be satisfied that those species which have survived the criticisms of two such competent judges as Dr. Harvey and Professor Agardh, working in complete independence of each other, are genuine. Undoubtedly a considerable number of *Rhodophyceæ* still remain to be discovered —in fact, I have now some undescribed species. Even in Britain itself fresh indigenous species are still being brought to light, and certain kinds of Algæ (*e.g.*, shell-boring species) have not even been looked for here.

The collection sent Home by Professor Parker included fifty-one species, of which one only (*Rhodocorton parkeri*, Gibson) is new to science. Professor Harvey Gibson seems to have fallen into a strange mistake with regard to the habitat of this plant. He states that he obtained it "growing at the base of a cluster of molluscan (?) eggs."* Thanks to

* "Journal of Botany," June, 1893, p. 163.

Professor T. J. Parker, I have seen one of the type specimens, and I find that the plant is epiphytic on the well-known Alga, *Lychæte* (*Conferva*) *darwinii*, Kuetz. This being somewhat decayed has perhaps caused it to be mistaken for molluscan eggs. Professor Gibson's list contains fifteen species which are not included in that of Agardh. Of these, the majority are Australian forms, not previously recorded from New Zealand. In one or two cases I am by no means certain of the synonymy, so that this number may not be quite accurate. I attach a list of them to the end of this paper. Special mention should perhaps be made of *Microcladia coulteri*, as the genus is here recorded for the first time from the Australian region. I have for the last two years been aware of the existence of this genus in New Zealand, but have not announced it, as I was not sure that our plant was specifically identical with the Californian *M. coulteri* (Harv.). If it be the same, the plant must be variable. I have specimens of this genus from Taylor's Mistake, and I have also received it from Dr. Chilton, of Port Chalmers, who obtained it at Long-beach, North Otago Heads.

Our list of New Zealand marine Algæ will now comprise 307 species, omitting the *Protophyceæ*. It is made up as follows: Agardh's list, 275; Corallines, 12; Harvey Gibson's list, 15; sundry, 5: total, 307.

Those marked "Sundry" include *Griffithsia sonderiana* (J. Ag.), *Ceramium stichidiosum* (J. Ag.), *Asparagopsis armata* (Harv.), *Landsburgia myricifolia* (J. Ag.), *Ulva bullosa* (Roth.). *Griffithsia sonderiana* should probably replace *G. setacea* of Agardh's list; but I retain both for the present. The next three mentioned are probably accidental omissions from Agardh's list. *Ulva bullosa* appears in Hooker's Handbook, with a (?) attached, and no habitat is given. It is omitted altogether from Agardh's list. I have, however, specimens of what is doubtless Hooker's plant, collected by Mr. T. Kirk, F.L.S., at Rocky Nook, near Sinclair Head, and by myself at Oriental Bay, Wellington. It must be remembered that the morphology of most of our species is not only known, but their fructification and internal structure have also been microscopically examined.* Of course, much still remains to be

* Nullam Florideam in systemate rite dispositam considerare decet, cujus structura interna et fructus nobis non sint omnibus numeris cogniti; neque certum judicium ferre licere de iis speciebus auctorum, quæ aut steriles descriptæ vel delineatæ, aut analysibus fructuum et structuræ erroneis aut deficientibus tantum cognitæ sunt. Quamobrem in hoc volumine, velut in antecedentibus, nullum speciem in textum adscivi, quam non ipse examinavi; species a me non visas aut in notis, aut inter species inquirendas, enumeravi. Paucissimas, facilius distinctas, iconi tantum fidens, hac auctoritate adoptavi. ("Epicrisis Systematis Floridearum." J. G. Agardh. Præfatio, pp. 1, 2.)

done; but I think we may assume that in most cases the position of the species has been determined from its fundamental and not from its external characters.

Perhaps the first thing to be now noticed is the numerical proportions of the green, brown, and red seaweeds in our list. They are respectively 24, 55, and 228. "Now," says Mr. G. Murray,* "while in the arctic and Australian regions the *Phæophyceæ* far outnumber the *Chlorophyceæ*, in the tropical West Indian flora the proportion is very markedly reversed, and the green Algæ outnumber the olive-brown." One would imagine at first sight that this was due to the stronger illumination of the tropical seas; but Mr. Murray believes that the irruption of fresh water from the Orinoco and the tideless character of the Antilles are probably largely contributing agents to this result. Be this as it may, in New Zealand the *Chlorophyceæ* number only 44 per cent. of the *Phæophyceæ;* in the neighbourhood of Port Phillip the percentage increases to 65; for the Cape of Good Hope it is 71; and for the Indian Ocean it is 103: in Great Britain it is 68. There is here evidently a marked connection between the latitude and the percentages given. It may, of course, be objected that the area of the Port Phillip district is too small to compare with the others. I chose it because there are recent statistics† for it, and thorough collections have been made from the locality. However, taking the most recent numbers for the whole of Australia,‡ the percentage is 55. This is probably too small, as many of the *Chlorophyceæ* are minute, and would escape notice unless very close search were made. It should also be remembered that the Algæ of southern are very much better known than those of northern Australia. On the other hand, it should be pointed out that the figures as given in the "Flora Antarctica" and in Dickie's list for Kerguelen Land§ show that in the antarctic district the numbers are about equal. This unexpected preponderance of green forms is to be accounted for, as will presently be seen, by the strange absence of the *Fucaceæ* from the antarctic flora.

Of course, the importance of these figures is in their bearing on the functions of the pigmentation of the Algæ and of plants in general, the question at issue being, Does the chlorophyll act as a filter to allow only the useful rays of light to pass through, or is it an absorbing agent, collecting and utilizing

* Trans. Biol. Soc. Liverpool, vol. v., p. 178.

† "Catalogue of Marine Algæ collected near Port Phillip Heads," by J. Bracebridge Wilson, F.L.S. ("Proceedings of the Royal Society of Victoria," vol. iv., part 2.)

‡ "Journal of Botany," July, 1893, p. 210.

§ Phil. Trans. Roy. Soc., vol. clxviii.

those which are most serviceable to the plant in the decomposition of carbon-dioxide? The latter view has received the most support.* The same question may be asked in a slightly different form with regard to the phycoërythrin of the *Florideæ* and the phycophæin of the *Phæophyceæ*. Do these pigments act as a protection against the blue light of the sea, or do they absorb special rays, and give them out with altered wave-length, more suitable to the needs of the plant? It seems to me that in the present state of our knowledge discussion of the relative percentages in different districts of brown, red, and green seaweeds will help us but little to a solution of our difficulty, though perhaps the increase in the percentage of green seaweeds towards the tropics is easier of explanation by the theory of absorption and alteration of wave-length than by the theory of protection. Data as to the depth to which species attain in different localities, and as to the variation of shade and tone with the depth, would probably be instructive.

It may be worth while to put on record here that I have observed in *Champia novæ-zealandiæ* a remarkable iridescence, consisting chiefly of blue and green rays. When in the water the plant in this respect reminds one strongly of the brilliant iridescent elytra of certain beetles. On removing the specimen from the water the iridescence to a large extent disappears, and there is not a sign of it after the plant has been dried. According to Kerner,† whose theories, if not always accurate, are frequently remarkable, and very often suggestive: "Several of the sea-inhabiting *Florideæ*, and sea-wracks belonging to the genera *Phyllocladia*, *Polysiphonia*, *Wrangelia*, and *Cystoseira*, even exhibit under the water a peculiar luminosity which may be compared with that of the luminous moss, although the optical apparatus is here essentially different. In the superficial cells of the luminous *Phyllocladias* are to be found plates segregated out of the protoplasm and closely adhering to the outer walls, which contain a large number of small, crowded lenticular bodies. From these minute lenses the green and blue rays are chiefly reflected, and thus the peculiar iridescence is produced. But, on the other hand, yellow and red rays are refracted on to the chlorophyll granules, and consequently these plates must be regarded as an apparatus for focussing the light, which, by its passage through the thick layers of water, has undergone a considerable diminution."

It will be interesting to examine our *Champia* and see if any similar structure can be made out in it. I have not seen the original paper which is Kerner's authority for his statements. He also affirms in a short passage (*loc. cit.*) that may

* "Physiology of Plants," p. 156: S. H. Vines.

† "The Natural History of Plants," English translation, p. 388.

be worthy of quotation as new to most of my readers that, "If the barrel-shaped and spherical cell-structures connected into chains, the cyst-like and berry-shaped outgrowths of the unicellular Caulerpas and Halimedas . . . are accepted as contrivances by which light is collected and focussed on those places within the cells where chlorophyll bodies are heaped up, then no mistake will be made." If there is any truth in this statement our *Lychæte darwinii* and *Caulerpa sedoides* should serve excellently well to prove it.

The next point to which I must draw your attention is the proportion of species to the genus in our Algæ. As we have 307 species distributed among 117 genera, it is evident that we have just over two and a half species to the genus. According to Mr. G. Murray,* "In the warm Atlantic the genus averages well over five species; in the Indian Ocean the proportion is nearer four than three species to the genus; while at the Cape it is almost exactly three. This is instructive, when we remember, as I have elsewhere† pointed out, that, while the arctic Algæ average slightly more than two species to the genus, the West Indies and Australia average rather more than five. I estimate that the north temperate Atlantic yields an average of about four and a half species to the genus."

Thus it appears we have only about half as many species to the genus as Australia has, but, as there are apparently only about three species to the genus at the Cape, it would probably be too venturesome to say that the small proportion in New Zealand is due to the fact that we are dealing with an insular rather than with a continental flora. It must be noted, however, that the Algæ of the Cape are probably not so well known as those of New Zealand. On the other hand, as our coast-line is varied in character, and extends through more than ten degrees of latitude, we might have anticipated that those genera which have obtained a footing here would have developed many species, but this appears only to have been the case in such genera as are variable elsewhere,—*e.g.*, *Polysiphonia*, *Gigartina*, *Delesseria*, *Cladophora*.

This leads us up to the question of the distribution of our species. It may be as well to point out, for the help of the general reader, that marine Algæ are not so widely distributed as might on first thoughts be imagined. Indeed, it might be supposed that the only limitations to their distribution would be due to unsuitable environment; but this is by no means the case. In spite of the great geological age of this class of plants, and their marine habitat, many of them are local in distribution. The deep sea is, generally speaking, a barrier

* "Phycological Memoirs," part ii., pp. 66, 67.
† Trans. Biol. Soc. Liverpool, vol. v., p. 77.

between them, and so are long reaches of sand and the mouths of large rivers. As I have been unable to find any observations on this matter in the books at my disposal, it would, perhaps, be as well to illustrate these statements from our New Zealand Algæ. Amongst other species endemic to the Chatham Islands is a very distinct form of *Landsburgia* (*L. myricifolia*, J. Ag.). It is a fucoid several feet in length, and it must often, like *L. quercifolia*, be torn from the rocks by the waves; and yet, although it could almost certainly survive a lengthened tossing on the ocean's surface, it has been unable to establish itself on the mainland. It should, perhaps, be pointed out that after the hold of the rhizoid has been loosened, or when the plant—as generally happens with some species—is broken off above it, there is, probably, no possibility of its being able to affix itself again. At least, I do not remember having seen a plant that had evidently once been afloat re-establishing itself. It might, of course, although it had been subjected to weeks of tossing on the ocean's surface, go on producing spores, which might have a chance of germinating if the plant were finally cast up on a rocky shore. If a comparatively narrow arm of the sea can form a barrier to a strong, coarse plant like this, much more so will it be one to the delicate *Rhodophyceæ*. These plants soon bleach and disintegrate under the influence of the sun's light and heat when on the surface of the water, so that it is extremely improbable that the smaller forms could cross in a living condition a wide arm of the ocean; and it is very improbable that even the larger forms could live for a lengthened time on the surface of the sea. Moreover, as we shall see presently, the facts of distribution do not by any means favour the supposition that ocean-currents do distribute living Algæ broadcast on the shores which they wash. It is still more difficult to imagine that oospores and carpospores apart from the plant should be able to cross successfully many miles of ocean.

I do not wish for a moment to deny that oceanic currents do sometimes determine the distribution of Algæ. The most notable example of this is perhaps to be seen in the case of *Macrocystis*, which follows the cold antarctic current up the western coast of South America, though not up the eastern side. Here, however, it is the temperature of the current, and not its direction, that determines the existence of the species. There is, however, a method by which even delicate species might in some cases be conveyed from shore to shore—that is, as epiphytes. *Macrocystis*, for example, apparently flourishes like the Sargasso weed in the open ocean.* If a plant

* "Flora Antarctica," vol. ii., p. 465.

was torn from the coast-line, carrying with it many epiphytic species, it might remain an indefinite time in the ocean, breaking up under the influence of the waves, &c., growing and carrying with it a colony of delicate epiphytes, some of which might thus in the course of time be drifted on to the shores of other lands.

It is to be remembered that a seaweed having reached a new and suitable habitat has not necessarily to contend with species already occupying the coast. There is always plenty of room for it to live—plenty of unoccupied and suitable positions in rock-pools and in the neighbourhood of the tidal area. The flora of the sea does not clothe the rock-surface with a mantle as the herbage does the land. Every heavy gale with spring-tides tears hundreds of tons of Algæ from the rocks, leaving plenty of bare surface for newcomers or for germinating plants. What are the chief factors in the struggle for existence amongst marine plants I do not know ; but it can scarcely be in the successful crowding-out of weaker competitors. Possibly the power of clinging successfully to the rocks is one of the chief of them ; but, whatever they may be, we undoubtedly frequently find species restricted to a definite area.

In New Zealand we have many long stretches of sand and shingle that are practically marine deserts as far as the Algæ are concerned. Thus, on the west coast of the North Island, from Paikakariki northward to Taranaki Province, there is an unbroken barren beach. Now, in the neighbourhood of the Sugarloaves, at the New Plymouth Breakwater, the common form of *Carpophyllum* is the one figured as *Sargassum phyllanthum*, pl. vii., "Atlas Botanique: Voyage de 'l'Astrolabe.'" This plant, however, is quite distinct from the true *Carpophyllum phyllanthum*, and is either a neglected species or a strongly marked variety of *C. maschalocarpum*. From Paikakariki southward the ordinary form of *C. maschalocarpum*, together with *C. phyllanthum*, is common ; and on this portion of the coast I have only found the New Plymouth form on rare occasions in drift-weed on the beach at Ohiro Bay, whither it may have come with the current from Taranaki. Thus a sandy track here separates two distinct and practically discontinuous varieties. Climate, which, of course, is the main agent in determining distribution along a continuous coast-line, can scarcely be said to play a part here, much less in the case of *Lessonia varieyata* (J. Ag.). This is abundant in deep tidal pools near Wellington Heads, and it extends along the coast to some little distance past Cape Terawhiti, when it disappears, although the coast-line continues of the same character northward as far as Pukerua. Its place is partially taken by *Ecklonia*. Here it is extremely difficult to account for the local distribution.

Not much, however, is at present known about the internal distribution of our species. As the islands stretch through ten degrees of latitude there is sufficient difference of temperature to cause considerable differences in the marine flora. Many of our species are principally or exclusively northern in their distribution, others are only found in the southern portion of the Islands. Of course, many plants which are at present known from restricted habitats in New Zealand will doubtless be found to be widely distributed. I have already a considerable list of new localities, but I will leave it for some future occasion, as I do not wish to burden this paper with it, nor do I intend to discuss further the distribution of our species within New Zealand.

There now remains to discuss the external distribution of our Algæ, which is of considerable interest. It should first be pointed out that no important order is wanting in our list, though several of the smaller ones appear to have no representative here. The small order, *Squamarieæ*, which is found throughout the Atlantic, in the Indian Ocean, at the West Indies and the Cape, and in Australia, is probably the most considerable of these. Our genera, too, as might be expected in such an ancient division of plants, are, as a whole, very widely distributed. It is, of course, to be expected that they should be most closely allied to those of the corresponding latitude in Australia, and this is the case. In south-eastern Australia there are about 180 genera, in New Zealand about 116. Of these, eighty-nine are common to both districts. The warm Atlantic and the Cape have eighty-five genera, and the Indian Ocean and the Cape eighty-six genera in common (G. Murray, *loc. cit.*). Of course, the percentages in each case show greater differences, but it will be seen that the large proportion of genera common to New Zealand and south-eastern Australia is not necessarily any proof of the close affinities of the floras. We have, for example, more than fifty genera in common with a district so remote and so different in climatical conditions as the West Indies. On the other hand, there are only eight genera confined to Australia and New Zealand—viz., *Hormosira*, *Xiphophora*, *Cystophora*, *Notheia*—amongst the *Fucaceæ*; and four genera in the *Rhodophyceæ*, all belonging to the order *Sphærococcoideæ*—viz., *Curdiæa*, *Melanthalia*, *Sarcocladia*, and *Dicranema*—but, of these, *Sarcocladia* consists of only two species—one belonging to Western Australia, and the other, a New Zealand one, only very doubtfully placed in the genus by Agardh. There is also a very doubtful species of *Dicranema* from the Red Sea. Such well-defined and distinctive genera as *Hormosira*, *Xiphophora*, *Cystophora*, and *Notheia*, however, prove a distinct connection between our

Fucaceæ and those of Australia. Indeed, the distribution of the nine genera of this order found in New Zealand is sufficiently remarkable to be summarised here. Five are confined to New Zealand and Australia, two are endemic to New Zealand. One is tropical in distribution; and the last—*D'Urvillæa*—is clearly antarctic, being confined to New Zealand, the Falklands, Cape Horn, and Kerguelen's Land; but even this is represented in Australia by the closely-allied and scarcely generically distinct *Sarcophycus*. Our two endemic genera are also Australian in their relationships. *Landsburgia* finds its closest ally in the genus *Phyllospora*, which is represented in Australia, and *Marginaria* comes nearest to *Scytothalia* of Western Australia and Tasmania. This last genus, however, is probably to be regarded as antarctic rather than Australasian, for there is a species (*S. obscura*, Dickie) in Heard Island, and another (*S. jacquinotii*, Mont.) in South Shetland. Harvey and Hooker comment on the last-mentioned plant in a noteworthy passage, part of which I shall quote, as it bears on the present discussion:—

"*Scytothalia jacquinotii*. *Hab.* Graham's Land, 63° S.; Deception Islands; South Shetlands.

"The existence of this seaweed on the icy shores of an antarctic land, in the longitude of Cape Horn, is a most singular and anomalous fact, for I believe it to be the only species of the tribe which inhabits the colder or antarctic seas of South America."*

Again, p. 457: "No such obstacle [*i.e.*, difference of temperature] prevents the fullest interchange of *Cystoseireæ* between New Zealand and the temperate seas of South America. It however is the fact that, whilst this group literally abounds in certain latitudes and longitudes, which are those of New Holland and the west Pacific, they are nearly absent from analogous positions in the longitude of South America."

I may add to this that the "Challenger" Expedition has shown they are also absent from the antarctic islands.

To sum up, then, six of the New Zealand genera of *Fucaceæ* are found in Australia, and four of them are confined to the two regions, whilst a fifth, *Carpophyllum*, is only represented elsewhere by a single species—*i.e.*, *C. scalare*—at the Cape. The remaining three are allied to Australian forms; but two of them are also antarctic in distribution. On turning to the New Zealand species belonging to these genera we find that, out of twenty-one, ten are confined to Australia

* "Flora Antarctica," vol. ii., p. 456.

and New Zealand, one is antarctic, and ten are endemic. Here, again, we have a clear illustration of the Australian connection.

But this connection must not be exaggerated. A reference to a different district will be useful to us here. Seventy-seven per cent. of our genera are found in Australia; 60 per cent. of the Cape genera are also found in the Atlantic and Indian Oceans. From an estimate of this crude description, it appears that as far as ratios go our connection with Australia is rather closer than that of the Cape with the East Indies or the warm Atlantic; but it must be remembered that the Algæ of Australia are highly characteristic, and, whereas in New Zealand we have only nine endemic genera—viz., *Marginaria*, *Landsburgia*, *Scytothamnus*, *Chladymenia*, *Apophlœa*, *Eodes*, *Ectophora*, *Abrotcia*, *Pandorea*—there are in the neighbourhood of Port Phillip alone representatives of about fifty genera confined to Australia, or, while 8 per cent. of our genera are endemic, about 28 per cent. of those found in south-eastern Australia are exclusively Australian. Thus, while our marine flora has marked affinities with that of Australia, there are also marked differences between them, many of the most distinctive and prominent Australian genera being unrepresented here. This, of course, only confirms what we know of the origin of our flora from the evidence of the flowering plants and ferns.

But the study of percentages, whilst giving an appearance of reliability, is very apt to be deceptive, and more striking and reliable information is sometimes to be obtained from the examination of limited groups. We have already seen that our *Fucaceæ* are largely Australian, and before passing on to the examination of the distribution of our species I must call attention to the distribution of the New Zealand genera of the order *Laminarieæ*. Our representatives of this order have undoubtedly an antarctic *facies*. They are five in number—viz., *Adenocystis*, *Ecklonia*, *Lessonia*, *Macrocystis*, and *Chorda*. Of these, *Adenocystis* and *Lessonia* are antarctic in their distribution; *Macrocystis* and *Ecklonia*, though not exclusively antarctic, reach their greatest development in the colder southern seas. The genus *Chorda* is represented by one species here —*C. lomentaria*, said to be found in Tasmania, Falkland Islands, North Atlantic and Pacific Oceans. I doubt, however, whether the southern plant is specifically identical with that of the Northern Hemisphere. That our *Fucaceæ* should be mostly Australian, but the *Laminarieæ* largely antarctic, is a remarkable fact, which I shall not attempt to explain.

It remains now to consider the distribution of our species. In these our shores are comparatively poor. We have only

307, as against 474* in Great Britain (excluding in both cases the *Cyanophyceæ*). Of course, the difference is to be attributed in part to the greater completeness of the British list. Australia, our nearest neighbour, is, on the other hand, remarkably rich in its marine flora. Mr. Bracebridge Wilson has collected at Port Phillip Heads and its neighbourhood no less than five hundred species of Algæ—a remarkably rich harvest from one district. When we remember what a long and varied coast-line New Zealand possesses we may, I think, reasonably say that further search will probably considerably enrich our flora. No collections have been made in the West Coast Sounds since the time of Hooker's Handbook. Dredging there would probably reveal a few, perhaps many, species of *Florideæ*. Remembering the imperfections of our list, we may roughly classify our species as follows :—

Endemic to New Zealand	162
Endemic to New Zealand and Australia	46
Widely distributed over northern and southern seas ..	47
Antarctic	31
Confined to southern, or to southern and warmer seas ..	21
	307

I think that this list, however crude as a representation of actual facts, will be found to be accurate as far as our present knowledge goes. It, however, requires a little explanation. The definition of "antarctic" adopted is that given in the "Flora Antarctica," vol. ii., p. 210, *et seq*. In the case of two or three species out of the thirty-one, its application may be doubtful; but that it is correctly applied in the remaining cases will be clearly seen shortly. Of the twenty species included under the heading "Confined to southern, or to southern and warmer seas," some four or five seem to be confined to New Zealand, Australia, and South Africa; nearly all the others extend northwards into the tropics; one or two perhaps should be considered as antarctic, but they are widely distributed.

From the above table it will be seen that about 53 per cent. of the known New Zealand species are endemic. It might have been supposed that in such an old division of plant-life specific stability would obtain through a considerable length of time, geologically speaking, but this is manifestly not the case. The fact that we have such a large proportion of endemic species shows that here as well as elsewhere there has been among the marine Algæ considerable development in comparatively recent geological times. We have, moreover, a considerable number of variable species; but here it is difficult to say how far the variations are due to the direct action of the environment during the life of the individual, or to more

* Revised List of British Marine Algæ, by Holmes and Batters.

subtle inherited tendencies. Such a variety as *Hormosira sieberi*, some bleached forms of *Cystophora*, and a certain variety of *Jania micrarthrodia*, are due to the plants living in pools that can only be reached by the highest spring-tides. Situations and external circumstances likely to modify the normal form of the plant should always be noted in collecting varieties.

It is rather remarkable that while we have so many endemic species so few of the remainder should be exclusively Australasian. We have already seen that about a fourth of these belong to the *Fucaceæ*, the remaining three-fourths are Floridean. The green seaweeds are apparently too widely distributed to show any distinct kinship between the two districts. Future observers should remember that we may have from time to time adventitious additions to the Australian element in our flora. In these days of copper-painted and copper-sheathed ship-bottoms it is perhaps hardly likely that ordinary traders will bear across the Tasman Sea many living Algæ attached to their sides; but I have known several instances where hulks have lain long in some Australian port and then been brought across to New Zealand to do service here. Such vessels, if undocked preparatory to the journey, would bring across with them many living specimens of Australian animal and vegetable life.

The most interesting element amongst our marine Algæ is undoubtedly the antarctic, which may be again subdivided as follows:—

New Zealand antarctic, Tasmania (sometimes Australia) ..	12
New Zealand, South America, and antarctic islands ..	8
New Zealand and antarctic South America	6
New Zealand and antarctic islands	5
	31

As these results are of some importance I attach a complete list of these species, giving details of the external distribution. Now, it is to be noted that no less than 10 per cent. of our species are antarctic in distribution; of these, a half, or 50 per cent., are found in Kerguelen, and about the same percentage (twenty species) of South African Algæ are also found there; and this notwithstanding that South Africa is separated from Kerguelen by only 50 degrees of longitude, and New Zealand is separated from it by about 150 degrees. Moreover, it will be seen from the detailed list that no plant is common to the three regions.

Again, seven plants occur in New Zealand, the antarctic, and Tasmania, but not on the mainland of Australia. One or two of them, of course, may yet be found in Victoria; but several of them are so conspicuous that they could not be

overlooked even by a casual observer, so that their non-existence in southern Australia may be regarded as proved. Such are *Adenocystis lessonii*, *Lychæte darwinii*, and *Nitophyllum multinerve*. Why should these plants be found at such widely intervening points, but not have crossed Bass Strait? Why, again, should five plants be confined to New Zealand and the antarctic islands? And, lastly, why should only two of the thirty-one reach South Africa?

Of course, no matter what explanation be accepted, there will always be difficulties and anomalies in the way of its complete adoption. For example, *Codium adhærens* has generally been regarded as a plant belonging to warmer seas. It just reaches the south coast of England, and the coldness of the waters of the Atlantic was believed to prevent it from spreading northward. However, it occurs plentifully in New Zealand, and the "Challenger" has shown that it is also found at Kerguelen. Nevertheless it is wanting both at the Cape and Australia. The genus *Microcladia* occurs on the coasts of the Atlantic, California, New Zealand, and Kerguelen. As the species are small, it may, however, be yet found in the intervening positions.

There are at least six possible solutions of our difficulties: (1) Further knowledge may fill in gaps at present existing, and reduce apparent anomalies; (2) dispersal may have taken place by other methods than those already referred to; or the present distribution may be due—(3) to existing, or previously existing, ocean-currents, (4) to the partial extinction of species once widely spread, (5) to the former greater extension of land-surface in the southern oceans, or (6) to some combination of some or all of these causes.

From what has already been said it will be clear that the first hypothesis is quite inadequate to solve our difficulties. In other branches of botany the reconciliation of opposing statements has frequently been attained to by a more careful attention to synonymy; but it should be pointed out that Agardh and Harvey are practically our sole authorities for Australia and New Zealand, so that there is here likely to be but little confusion owing to varying estimates of specific and generic differences. In the other districts referred to the naming of the species has been carried out with the greatest care by recent investigators. Contrasts may be lessened in some cases by further investigation, but resemblances are much more likely to be strengthened than diminished; and many species are so distinct and so abundant where they do occur that the negative evidence of their omission from a list must be regarded as satisfactory proof that they do not occur in the district.

The second conjecture need not detain us long. The only

other method of distribution besides those already referred to that occurs to me as being worthy of mention is that by means of sea-birds.

It is by the agency of these that Sir Joseph Hooker endeavours to account for the existence of the phanerogamic flora of Kerguelen's Land,* but it is practically hopeless to account for the distribution of our seaweeds by any such method. Many of them live below low-tide mark, and so would scarcely be likely to be picked up by birds except as drift-weed. Some of these with anomalous distribution are extremely delicate and very small—*e.g.*, *Polysiphonia ceratoclada*, which grows to a length of 15mm. or 20mm., and is less than 1mm. in diameter. It is, however, a very distinct and recognizable species. It is common in New Zealand, and has been reported from Amsterdam and St. Paul Islands. Such a distribution could scarcely have been effected by sea-birds. Still, this is a single extreme case, and of itself does not disprove or prove anything. It is merely to be taken as a typical example of the difficulties to be met with, and is only to be regarded in conjunction with other facts. If, again, sea-birds have been distributing-agents, why should they have carried so many Fuegian and New Zealand forms to Kerguelen and Tasmania, but not to South Africa and southern Australia? Whatever may have been their work in distributing land-plants, I think that they may have been practically left out of consideration as distributors of the Algæ. If this is so, then the discussion is somewhat narrowed down; and it may be possible to get from the Algæ more definite evidence upon various questions of distribution than is obtainable from the flowering plants.

We have now to refer to the action of ocean-currents. I have already shown that in many cases these have been unable to establish a species on the further side of a comparatively narrow ocean-barrier, even when similar conditions appear to exist in both localities. Sir J. Hooker, however (*loc. cit.*), states that "oceanic currents have doubtless brought the marine Algæ to Kerguelen Land." This may be true for the majority of them, but I cannot think that it is true for all. For example, under this hypothesis, why should *Adenocystis lessonii*, *Polysiphonia abscissa*, *Nitophyllum multinerve*, and several other species have drifted from Fuegia to Kerguelen, but not from Tasmania to Australia? or how did *Calophyllis hombroniana*, *Antithamnion ptilota*, and two or three other species reach the antarctic islands from New Zealand without establishing themselves at intermediate points? Whatever may have been the centre of distribution, we cannot account

* Phil. Trans. Roy. Soc., vol. clxviii., p. 13.

for these facts by the action of oceanic currents alone, even if in past time they were different in direction from those at present existing. Moreover, the distribution of the *Fucaceæ* and the *Laminariceæ* gives a character to the antarctic Algæ that seems to denote something more than dispersal from a common centre.

However, a full discussion of this question would involve an investigation into the distribution of the seaweeds throughout the southern ocean, and would lead me quite outside of the scope of this paper. We have in ocean-currents no doubt a *vera causa*, but what the limits of its action are would be a very difficult matter to determine. The generally westerly drift in the forties will no doubt go far to explain some of our difficulties. It may possibly account for the presence of some Fuegian forms in Tasmania and New Zealand, but not in Australia; and the trend of this current at the south of the Cape may explain the absence of Fuegian plants there. In speaking of *D'Urvillæa utilis*, Hooker says, "Though carried by the currents along the ocean to the south of the Cape of Good Hope (for it was collected in that meridian in the 51st degree, floating in the open ocean), it does not appear to inhabit or be cast upon the southern extremity of Africa."* Such statements as these, in the absence of knowledge as to the age of the species and of oceanic currents, can only be looked upon as conjectures; but, making every allowance for their possible truth, there is still, I think, presumptive evidence in the facts already given that other causes have been at work in determining the present distribution of the Algæ in southern oceanic islands.

Whether species at present discontinuous may at one time have been widespread we are not likely to be able to determine, nor can we consider this as a means of explanation until extraneous evidence has been brought forward to show that areas at present widely separated were more closely connected in the past. Such evidence is not altogether wanting. The theories of Mr. A. R. Wallace† and Captain Hutton‡ are well known here, and I need scarcely refer to them further; but I should like to quote a short passage that may not be so well known to New Zealand readers, from the "Botany of the 'Challenger'"§:—

"The now complete botanical researches for the present work have brought to light some interesting facts, confirming generally the views enunciated by Darwin, Hooker, and

* "Flora Antarctica," vol. ii., p. 455.

† "Island Life," 2nd ed., chap. xxii.

‡ "New Zealand Journal of Science," vol. ii., p. 1: "Origin of the New Zealand Fauna and Flora."

§ "Botany of the 'Challenger,'" vol. i., pp. 4, 5.

Wallace, and more fully set forth by Wallace in the book under consideration [*i.e.*, 'Island Life']. There is, however, one important exception. All Wallace's speculations on former land-connections are based upon the present relative depths of the intervening seas, and, while admitting, or rather suggesting, a former land-connection between New Zealand and eastern Australia, he utterly rejects Captain Hutton's theory of a southern continent uniting the former with South America, and perhaps also with South Africa. Without going as far as Hutton, we think the botanical evidence, as explained further on, strongly favours a former greater land-connection in a lower latitude in the south temperate zone than Wallace admits, and we cling to 'this forlorn hope of the botanical geographer,' as Sir Joseph Hooker terms it, for all the various means by which plants are diffused seem to be inadequate to account for the present distribution of plants in the coldest southern zone of vegetation."

Again, Mr. Botting Hemsley, commenting on the land-plants of Kerguelen,* says,—

"Numerically, then, there is a preponderance of Fuegian forms represented in Kerguelen and the other islands under consideration as to what may be termed New Zealand forms. The antarctic flora may have spread from America; but with all the facts before us there does not seem to be a special affinity between the floras of Kerguelen, &c., and Fuegia, as distinguished from the flora of the zone generally. Taking the New Zealand flora as a whole and the Fuegian flora as a whole, the former is as strongly represented in these islands by the same and allied species as the latter, indicating a former flora of the same elements spread all round a southern zone, which included a part of New Zealand and the extreme south of America, as well as the present isolated spots of dry land in the same latitude."

The statements here are based on the evidence derived from only twenty-seven flowering plants and ferns. On turning to our Algæ we find that the statements made above are on the whole confirmed by them. There are twenty-two species occurring in New Zealand and the antarctic islands, and twenty-five in New Zealand and South America and the neighbouring islands. Six are confined to New Zealand and South America, five are confined to New Zealand and the antarctic islands. Now, seventy-one species of marine Algæ are known from Kerguelen, and about 110 (neglecting *Protophyceæ*) from South America. Thus the two elements are represented here in about equal proportions, although the antarctic-island forms perhaps preponderate a little. It is, how-

* "Botany of the 'Challenger,'" vol. i., p. 253.

ever, to be remembered that we have probably excluded some antarctic species of the Campbell and Auckland Islands not found on the mainland of New Zealand. There is reason to believe that a thorough search of these islands would add considerably to our list of antarctic Algæ.

As a result of our whole investigation, I think that we may now fairly say that the examination of our Algæ has confirmed, and perhaps to a slight extent strengthened, the general results obtained by those who have similarly studied the flowering plants.

List of Antarctic Algæ found in New Zealand, to show their General Distribution.

(The specific identity in different localities of plants marked thus (*) is doubtful.)

(A.) *New Zealand, Antarctic, and Tasmania (sometimes Australia).*

1. *Lychæte darwinii*—Tasmania, Fuegia.
2. *Adenocystis lessonii*—Fuegia, Kerguelen, Tasmania.
3. *Ballia callitricha*—Australia, Fuegia, Falklands, Kerguelen.
4. *Ballia scoparia*—Australia, Fuegia, Falklands.
5. *Rhodymenia linearis*—Australia, St. Paul.
6. *Rhodymenia corallina*—Tasmania, Chili, Kerguelen.
*7. *Epymenia membranacea*—Southern Australia, Cape Horn, Tristan d'Acunha, Marion Island, St. Paul (Cape of Good Hope).
8. *Bostrychia harveyi*—Australia, Chili, (doubtfully antarctic).
9. *Bostrychia mixta*—Tasmania, St. Paul (South Africa).
10. *Polysiphonia abscissa*—Tasmania, Fuegia, Kerguelen.
11. *Nitophyllum multinerve*—Tasmania, Cape Horn, Fuegia, Kerguelen.
12. *Melobesia antarctica*—Tasmania, Fuegia, Kerguelen.

(B.) *New Zealand and Antarctic South America.*

13. *Dictyota kunthii*—Chili, Juan Fernandez.
14. *Callithamnion flaccidum*—Cape Horn, Hermit Island.
15. *Gigartina fissa*—Cape Horn.
*16. *Nitophyllum variolosum*—Falklands.
17. *Nitophyllum d'urvillei*—Chili.
18. *Rhodomela gaimardi*—Fuegia.

(C.) *New Zealand and Antarctic Islands.*

*19. *Rhodoglossum latissimum*—Kerguelen.
20. *Calophyllis hombroniana*—Amsterdam Island.
21. *Delesseria dichotoma*—St. Paul.

22. *Polysiphonia ceratoclada*—St. Paul, Amsterdam Island.
23. *Antithamnion ptilota*—Crozets.

(D.) *New Zealand, South America, and Antarctic Islands.*

*24. *Lessonia variegata*—Chili, Kerguelen.
25. *D'Urvillæa utilis*—South America, Falklands, Kerguelen.
26. *Calophyllis variegata*—Fuegia, Chili, Kerguelen, St. Paul.
27. *Calophyllis tenera* — South Shetland, Kerguelen, Amsterdam Island.
28. *Delesseria davisii*—Fuegia, Kerguelen.
29. *Delesseria quercifolia*—Fuegia, Kerguelen.
30. *Delesseria crassinervia*—Fuegia, Kerguelen.
31. *Ptilonia magellanica*—Cape Horn, Kerguelen.

Algæ new to New Zealand in Professor Harvey Gibson's List.

1. *Corynophlæa umbellata*, J. Ag.
2. *Corynophlæa cystophoræ*, J. Ag.
3. *Rhodocorton parkeri*, Harvey Gibson.
4. *Antithamnion ptilota* (Hook. et Harv.), Harv. Gibs.
5. *Pleonosporium brounianum* (Harv.), Harv. Gibs.
6. *Microcladia coulteri*, Harv.
7. *Nemalion ramulosum*, Harv.
8. *Gigartina flabellata*, J. Ag.
9. *Gracilaria ramulosa*, J. Ag.
10. *Polysiphonia hystrix*, Hook. et Harv.
11. *Polysiphonia mallardiæ*, Harv.
12. *Polysiphonia gaudichaudii*, Ag.
13. *Polysiphonia cloiophylla*, J. Ag.
14. *Curdiæa laciniata*, Harv.
15. *Melobesia amplexifrons*, Harv.

References.

Flora Antarctica, 1847. (Sir J. D. Hooker.)
Species, Ordines, et Genera Algarum, 1848–1863. (J. G. Agardh.)
Species Algarum, 1849. (Kützing.)
Flora Novæ Zealandiæ, 1853–1855. (Sir J. D. Hooker.)
Phycologia Australica, 1858–1863. (Harvey.)
Handbook of the New Zealand Flora, 1864. (Sir J. D. Hooker.)
Epicrisis Systematis Floridearum, 1876. (J. G. Agardh.)
De Algis Marinis Novæ Zealandiæ, 1877. (J. G. Agardh.)
The Marine Algæ of Kerguelen Land, 1879. (Dickie.) (Phil. Trans. Roy. Soc., vol. clxviii.)

Origin of the New Zealand Fauna and Flora, 1884. (Captain Hutton.) (New Zealand Journal of Science, vol. ii.)
Reports of the "Challenger": Botany, vol. i., 1885. (W. Botting Hemsley.)
Island Life (2nd ed.), 1892. (Wallace.)
Catalogue of Marine Algæ collected near Port Philip Heads, 1892. (Bracebridge Wilson.) (Proceedings of the Royal Society of Victoria, vol. iv., part 2.)
A Provisional List of the Marine Algæ of the Cape of Good Hope, 1893. (Ethel S. Barton.) (Journal of Botany, vol. xxxi.)
On some Marine Algæ from New Zealand, 1893. (R. J. Harvey Gibson.) (Journal of Botany, vol. xxxi.)
A Comparison of the Marine Floras of the warm Atlantic, Indian Ocean, and the Cape of Good Hope, 1893. (G. Murray.) (Phycological Memoirs, part ii.)

Art. XXXVIII. — *On the Preparation and Preservation of Botanical Specimens.*

By T. Kirk, F.L.S.

[*Read before the Nelson Philosophical Society, 5th November, 1894.*]

Although the process of drying plants for the herbarium is simple and inexpensive, it is no uncommon thing to find collections of specimens which are almost worthless for critical examination owing to the imperfect manner in which they have been prepared. In others the specimens are of little value owing to their fragmentary character. Culms of grasses without leaves, sedges destitute of fruits, the staminate flowers of a *Coprosma* without the pistillate, or the pistillate without the staminate, are of but little use to any one desirous of gaining a thorough knowledge of the plants under examination. Yet again, even well-selected and carefully-dried specimens, if without labels stating the locality in which each was gathered, are of no value to the student who desires to become acquainted with their geographical distribution. It may therefore be worth while to describe the simple apparatus required, and indicate the chief points which should receive attention in the preparation and preservation of herbarium specimens, although it is not easy to say anything new on a subject of this description.

Collecting.

For field-work the collector will require a strong digger or trowel, in order to obtain tubers, bulbs, &c., in an undamaged condition. The blade should be 6in. or 7in. in length, concave on the upper surface, 1½in. broad at the base, tapering to a narrow, rounded end, with sharp edges. The shank should be continued upwards for about 4in., and should have a piece of puriri or other hard wood riveted in the front and shaped to form a convenient handle. An old file may be made into an unbreakable digger by any intelligent blacksmith.

The vasculum, or collecting-box, may be of any convenient size or shape, according to the fancy of the bearer. It should be made of light sheet-zinc or tin, and lacquered both inside and out. Where a large number of specimens is not required, its length may be from 20in. to 24in. by 6in. or 7in. broad, and from 4in. to 5in. in depth. The sides and ends should be convex, and the lid should open nearly the full length and width of the upper side. A stout handle, large enough for the hand to be passed through, should be attached to the upper end, and two strong loops should be fixed on one side to allow of the box being carried by a strap when required.

Many collectors prefer to use a portfolio, which, like the vasculum, may be made of any convenient size; usually it will be found most advantageous if of the same dimensions as the herbarium-sheets. It can be made of two stout millboards covered with American cloth, and connected by a leather back. The whole should be secured by two light straps, with buckles, so that pressure may be regulated as required; and a convenient handle should be attached. It should be filled with folded sheets of any thin soft paper, about ¼in. shorter and narrower than the covers. Old newspapers cut to the proper size will answer the purpose. The specimens should be laid in the loose sheets, and the sheets removed to the drying-press on reaching home. It saves much time and trouble to keep small, delicate, or flaccid specimens in these rough papers until they are thoroughly dry.

For very small specimens a pocket press the size of an octavo volume is very serviceable. It may be made of common blotting-paper, with cardboard covers secured by stout twine, or even by elastic rings. A book may easily be utilized for a pocket press if nothing better can be obtained.

Thin sheet guttapercha will often be found a great convenience, especially when collecting aquatic plants, in the absence of a portable press. *Isoetes*, *Naias*, *Potamogeton*, and other water-plants, if tightly wrapped in this material, and packed so as to prevent bruising, may be kept in good condition for a week or ten days, and carried hundreds of miles without injury.

Many plants may be kept in the vasculum for several days if needed without sustaining injury. During protracted excursions this is occasionally a great convenience, but as a rule specimens should be placed in the drying-press as soon as possible after they are collected.

Preparation and Drying.

Specimens for drying should be as complete and characteristic as the circumstances of the case will allow. In many cases it is desirable to show the root, whether tufted or creeping, bulbous, tuberous, &c. Where there is any great difference of form or division between the radical and cauline leaves specimens of each should be preserved. Usually it is desirable to have not only the flowers but the fruit; in some orders the fruits are indispensable, as in the sedges. When the specimens are larger than the herbarium-sheets they may be cut into suitable lengths, or if slender the stem may be partially broken across or simply folded. The stiff and wiry stems of grasses and sedges, &c., may be kept in place by passing the folded portion through a slit in a piece of stiff paper. When the root or stem is thick, or too large to press without inconvenience, it should be split down the middle, or one side should be pared down. All unisexual plants, as *Coprosma*, *Podocarpus*, *Clematis*, &c., should be represented by specimens of the staminate and pistillate flowers, and whenever possible the fruiting specimens should be taken from the same plant as the female flowers. Fleshy plants, as *Mesembryanthemum*, should be placed in boiling water for two or three minutes, but should be wiped perfectly dry before being placed in the press. Bulbs, corms, tubers, &c., may be advantageously treated in the same manner. All specimens should be slightly shorter than the herbarium-sheets.

The simplest method of drying plants is to place them between sheets of absorbent paper under sufficient pressure to prevent the specimens from shrivelling or becoming brittle. In order to insure the perfect abstraction of moisture the damp papers must be replaced by dry ones at frequent intervals, which, except in the case of grasses and other thin plants containing very little moisture, should never exceed twenty-four hours for the first four days after specimens are placed in the press, and it will be all the better if the first change can be made within twelve hours. It is of the greatest importance that the damp papers should be removed at least daily for the first four or six days, as neglect at this stage cannot be remedied afterwards: neglected specimens, especially of soft plants, become discoloured, and never lose the whole of their moisture, but assume a flaccid condition, which renders them more liable to the attacks of insects and Fungi than specimens

that have received proper attention. Aquatic plants should have the external moisture wiped off before being placed in drying-papers, and should receive their first change within three or four hours of their being placed in the press.

The drying-papers should be of the same dimensions as the herbarium-sheets; the best quality is "Bentall's Botanical Drying-paper," which is manufactured specially for this purpose, and costs in London 19s. per ream for demy, 18in. by 11in. when folded. The well-known chalk-paper is almost equally good, but is more expensive; both these papers are of high absorbent-power and great durability. Thick blotting-paper is good, but not durable; old newspapers or any common paper may be used when better kinds cannot be obtained; the coarse brown paper tarred on one side for packing purposes affords good results. It need scarcely be said that, whatever kind of paper may be used, the sheets should be of uniform size, and when of thin quality several sheets should be folded together to save trouble in changing.

As already pointed out, if the specimens are placed on thin sheets at first, a great saving of time and labour will be obtained, especially with small or flaccid specimens, as the entire sheet can be placed between the drying-papers at once instead of lifting each specimen separately. Each specimen should be carefully laid out in such a way that the branches do not cross each other, and the flowers are properly displayed; some of the leaves should be arranged with the lower surface upwards. The specimen should be accompanied by a label showing the name of the plant, the locality in which it was grown, the date of collection, and the collector's name. Notes on habit, structure, &c., should be entered in the collector's note-book. On the specimen thus arranged two or more folded drying-papers should be laid, according to the quantity of moisture it contains, and the process must be repeated until all the specimens are disposed of. Care must be taken to divide the pile of specimens into sections by boards the size of the drying-papers, and $\frac{3}{8}$in. or $\frac{1}{2}$in. in thickness: stout cardboard will answer the purpose very well. Boards of the kind should also be used to separate plants gathered at different times. The pile of specimens must be placed under pressure, which may be applied in various ways. A board may be placed on the top, and the whole weighted with bricks, or bags of sand, or stones, &c; or cleated boards may be placed at the top and bottom of the pile, and the whole tightened with strong straps and buckles. A press of this kind forms a convenient travelling-press; thick sole-leather in place of the covering-boards increases its portability, but requires an additional strap which should be applied lengthwise. The most convenient form of press, however, is the screw-press. It is sometimes

urged against the screw-press that the pressure becomes relaxed as the moisture is extracted from the specimens. This, however, is theoretical rather than practical. As a matter of fact, when a press receives proper attention, and the wet sheets are replaced by dry ones—say, on alternate days—the pressure is not perceptibly relaxed: even if it were necessary to leave the press unchanged for several days, nothing would be more easy than to give an occasional turn of the screw.

A simple but effective portable screw-press which I have had in use for over forty years is made of ¼in. square iron, forming a frame 11½in. wide by 12in. in height; the middle portion of the upper side is enlarged and perforated with a chased aperture to receive the screw, which is from 6in. to 7in. long (including the head), and terminates in an obtuse point below. The exact weight of a press 11½in. by 12in. is 5lb.; a smaller size might be made out of ⅜in. square iron. A press of this kind never gets out of order, and is almost unbreakable, while it is quite as portable as a strap-press. Two of these portable presses may be carried on a pack-horse, leaving ample space between them for the tent and other field impedimenta. On Plate XXVIA. is shown the form of the press and the way in which it is used.

The amount of pressure required varies with the nature of the specimen. Many ferns and slender grasses, such as *Poa trivialis* and *Microlæna stipoides*, do not require more than from 20lb. to 30lb., but twice this weight would not be too much for robust kinds such as *Arundo conspicua*, *Danthonia flavescens*, &c. From 50lb. to 80lb. is sufficient for most herbaceous and for many woody plants, while from 80lb. to 100lb., or more, may be used for the larger species of *Aciphylla* and for stout, wooded plants with thick leaves. Overpressed specimens are often useless for examination.

With regard to the number of changes of paper and the length of time required for drying different plants, it is hardly possible to lay down hard-and-fast rules, as so much depends upon the state of the atmosphere. Slender grasses and ferns require but two or three changes, and may often be dried in a week or ten days; most plants, however, require at least a fortnight; thick-leaved and fleshy plants require three or four weeks, or longer. Submerged aquatic plants dry very quickly after the second or third change. But in these and similar matters a little practice and observation are of more value than much teaching.

Instead of solid boards for the top and bottom of the press, and for dividing it into sections, ventilators are sometimes employed. These may be made in various ways—say, of two interrupted layers of bars ½in. square of any common wood, the

length of each layer being regulated by the length or width of the drying-papers. The bars should be laid about 2in. or 2½in. apart, one layer crossing the other at a right angle, the whole being secured by wire nails at the points of intersection. A press arranged with ventilators on this plan does not require such frequent changes of paper, as much of the moisture is drawn off by air-currents passing through the ventilators, the amount largely depending upon the state of the atmosphere. In wet weather ventilators are of but little value. Sometimes the ventilators are made of woven wire strengthened by a marginal iron frame, but, except for outside covers, the results are less satisfactory than with the wooden ones previously described. A press of this kind may be placed in an open window with advantage.

The process of drying may be shortened by placing the press in a large oven, by using hot drying-papers, or by passing hot flat-irons over the separate layers of specimens.

The time requisite for preparing really good specimens, and the frequent changes of drying-papers required, have led to many attempts to discover some improved process, but the results have not been altogether satisfactory: still, two of these processes deserve brief mention.

Rather thick absorbent brown paper may be saturated with chloride of lime in solution. The sheets should then be dried in an oven, and enclosed in a perfectly air-tight box until wanted for use. The specimens should be laid in folded sheets of any thin paper, which should be placed between the prepared drying-papers, pressure being given by straps and buckles, when the press should be placed in an air-tight box, or protected from the atmosphere by being wrapped in oiled cloth. Ordinary specimens do not require more than a single change of drying-papers, and become thoroughly dry in a few days, the colour being well preserved; but, as a rule, specimens prepared in this way are very brittle. The drying-papers can only be deprived of absorbed moisture by being placed in an oven, and care must be taken to keep them fit for use by preventing the access of air as completely as possible.

A more advantageous process is to saturate water with sulphurous acid; then to add methylated spirit in the proportion of one to three. Thick-leaved plants, such as the larger species of *Celmisia*, &c., should be soaked in the fluid from twelve to twenty-four hours, according to the succulence of the leaves and stem. Plants with still thicker leaves may require from one to two days; while delicate and thin-leaved plants should only remain in the liquid from five minutes to an hour. It is imperative that all external moisture be removed by wiping or by exposure to dry heat before the specimens are placed in the press. Thin-leaved plants

treated by this process require a single change of drying-papers only; those with thick leaves rarely require more than three changes; so that time and labour are greatly reduced, while the colour of the flowers is better preserved than by any other process. It is, however, better adapted to herbaceous than to woody specimens. The methylated spirit might first be saturated with corrosive sublimate, when the specimens would be poisoned without further trouble.

Algæ, Musci, Characeæ, etc.

Delicate aquatic plants such as the finer marine Algæ require special treatment. A portion of the plant should be removed and after careful washing floated in a bowl of fresh water, when a suitable white paper may be placed underneath and the specimen gently lifted out. A camel-hair pencil may be used to arrange small branchlets while floating, and superfluous portions should be cut away with fine-pointed scissors before the specimen receives the final touches. The floated specimen should be placed on thick blotting-paper, and a sheet of oiled paper laid between the specimen and the superincumbent drying-paper to prevent adhesion. The pressure required in drying these delicate plants is very small, but they should receive their first change within two hours of being placed in the press; if changed quickly and frequently they become dry in two or three days. The larger coarse Algæ should be washed in fresh water and pressed in the usual way, oiled paper being placed immediately above the gelatinous species.

Full instructions for the preparation of Fungi and unicellular Algæ are outside the scope of this paper, but may be found in any good work on the preparation of objects for the microscope.

The delicate species of *Nitella* may be treated in the same manner as marine Algæ. Most of the species of *Chara* are strongly calcareous, and should receive the same treatment as ordinary flowering-plants; they are, however, easily destroyed by excess of pressure.

Mosses are easily dried in the ordinary manner. They require but few changes and little pressure. The finer kinds of Hepaticæ are remarkably delicate, and must be treated carefully, as overpressed specimens are of no value. Thick red blotting-paper is the best material for drying these delicate plants. The coarser Hepaticæ and liverworts may be dried in the ordinary manner. The same process may be applied to foliaceous lichens, but rupestral and saxicolous kinds and many Fungi are best preserved by drying at an air-temperature of from 80° to 90° Fahr., and mounting on small cards with a fragment of the rock or bark on which they grow.

The Herbarium.

A heterogeneous collection of dried plants, however well preserved, is of very little service, and can scarcely be termed an herbarium. The specimens must be named and arranged in a systematic manner so as to admit of easy reference, in order to economize time and labour. The herbarium may comprise the plants of a small district only, as of the Port or Provincial District of Nelson, or it may comprise the plants of an entire continent. It should be kept in an air-tight and dust-proof cabinet.

The first point to be determined is the size of the herbarium-sheets. Attention has been drawn to the desirability of the drying-papers being of the same size as the herbarium-papers, but the dimensions have not been considered. Much will depend upon the taste of the collector, but practically the choice lies between foolscap, demy, and folio. The first—13in. by 8in.—although often used for private collections, is rather too small to allow of characteristic specimens of many New Zealand plants. The first cost of the third—20in. by 12in. or 14in.—is needlessly large, while it is very cumbrous in the field, and involves an unnecessary expenditure of time and labour, without securing any corresponding advantage. Sheets of demy size, 18in. by 10in. or 11in., afford the maximum amount of convenience. In some herbaria the sheets are equal in length and breadth. The Linnean Herbarium is mounted on sheets of foolscap size; Bentham's Herbarium on small demy, 16½in. by 11in.; Cunningham's New Zealand Herbarium, on folio.

The sheets should be non-absorbent, hard, firm, and of even texture. A pale-brown tint similar to that of light cartridge-paper is to be preferred to white. All papers used in the herbarium should have perfectly even margins; even labels should not be exempted from this rule, as ragged margins invite the attacks of certain insects.

For all public herbaria, at least, the specimens should be poisoned before mounting. In private collections mounting may be dispensed with, and the specimens simply laid on the sheets. If the specimens are properly prepared, and constantly inspected, poisoning is not absolutely necessary for private collections. There is, however, great danger of the introduction of insects through badly-prepared specimens received in exchange. I have never poisoned a specimen for my own herbarium, although my experience has extended over fifty years. Sometimes insects have been introduced in specimens received from other collectors; but it has always been found possible to get rid of the invaders without poisoning, although not before a small amount of injury has been done.

The herbarium of Wellington College was formed in 1874–75: the specimens were mounted on sheets of white paper, but were not poisoned, and, although but little used of late years, the collection is scarcely touched by insects, having been kept in an excellent air-tight cabinet.

The most troublesome insects in the colony are *Anobium paniceum*, L., which has become almost cosmopolitan; two small moths; and one or two *Acari*. Another small beetle, apparently a species of *Ptinus*, is only occasionally met with. Camphor freely distributed through the herbarium tends to deter insects, but is not an infallible preventive. Biological specimens attacked by insects of any kind may be thoroughly cleaned by exposure to the vapour of carbon-dioxide, which destroys even the eggs; but this remedy is a dangerous one, and can only be applied under proper precautions, while its effects are transitory. The best poison for plant-specimens is common methylated spirit charged to a little below the point of saturation with corrosive sublimate: if fully saturated, an efflorescence will be left on such specimens as *Aciphylla*, *Ligusticum*, *Gentiana*, &c., which absorb it freely.* Large Compositæ, Ranunculaceæ, Umbelliferæ, Cruciferæ, Leguminosæ, Liliaceæ, &c., are specially attractive to insects. Myrtaceæ, Pittosporeæ, arborescent Saxifrageæ, Myoporineæ, Glumiferæ, and Filicales are rarely attacked. The poison should be applied with a soft brush, such as is used by house-painters: brushes with metal attachments should be avoided: thick specimens may be dipped in the solution. Where numerous specimens have to be treated, guttapercha or vulcanite trays, or photographic dipping-dishes, will be found useful.

Specimens are occasionally fastened to the herbarium-sheets by sewing, a process not to be recommended. Strips of adhesive paper may be employed with advantage, or they may be attached by washing the undersurface with a solution of gum-arabic and tragacanth or with weak glue: common paste should be avoided. In no case should more than a single species be placed on the sheet, although the specimens may be numerous. The name of the plant should be written at the lower right-hand corner of the sheet, together with the locality in which it was collected, the date of collection, and the collector's name. If specimens from more than one locality are placed on the sheet the name of each locality should be stated under the proper specimen. A neat form of ticket may be adopted if thought desirable.

The different sheets of the same genus should be placed

* The mixture used at the Kew Herbarium is composed of corrosive sublimate, 1oz.; carbolic acid, 1oz.; methylated spirit, 1qt.

in a generic cover, which when folded ought to be ¼in. longer and broader than the sheets on which the specimens are mounted, and of rather stouter quality: the name of the genus, and, if the genus contain numerous species, the name of the sub-genus or section, should be written at the right-hand corner.

The genera must now be arranged under their respective natural orders in systematic sequence and placed in the herbarium cabinet, which, as already stated, should be air-tight and dust-tight. A convenient size for the cabinet when demy paper is used is 36in. by 40in. and 21in. deep, outside measurement. This allows of twelve pigeon-holes 12in. by 8in. and 19in. deep. If sliding trays are required the width must be slightly increased. The outer edges of the cabinet should be bevelled inwards so as to allow of the doors being fitted as tightly as possible, and the hinges should fold backwards when required, so as to avoid projecting edges.

Mosses, Hepaticæ, and many Algæ are usually mounted on small sheets, which can be arranged in generic covers of the same size as that adopted for vascular plants: most lichens and hard Fungi should be mounted on small cards placed in shallow trays or drawers on account of the greater thickness of the specimens.

Art. XXXIX.—*On New Forms of* Celmisia, *Cass.*

By T. Kirk, F.L.S.

[*Read before the Nelson Philosophical Society, 10th December, 1894.*]

Celmisia macmahoni, n.s.

A small tufted species densely clothed with white silky hairs. Leaves crowded, forming a dense rosette, 1in.–1½in. long, ¼in. broad, including the short petiole, lanceolate or oblong-lanceolate, acute or subacute, thick, 5–7-nerved below. Scapes 3in.–5in. long, bracts numerous, linear-obtuse. Heads ¾in.–1in. in diameter; involucral bracts very numerous; outer acute, villous; inner acuminate, more or less clothed with short brown hairs: rays broad: achenes hispid: pappus very unequal.

Hab. South Island: Mount Stokes, 3,000ft. *P. A. Macmahon!*

A charming species, most nearly related to *C. incana*, Hook. f., but easily recognized by the long silky tomentum, which offers a strong contrast to the cottony tomentum of

that variable plant: it further differs in the short broad petiole, which rarely exceeds $\frac{1}{4}$in., and is nearly flat, brown above, but silky below, the leaves being much broader at their base; and in the crowded scapigerous bracts, which are clothed with very long silky tomentum.

C. hieracifolia, Hook. f., var. **oblonga.**

Leaves linear-oblong, obtuse, $1\frac{1}{2}$in.–$2\frac{1}{2}$in. long, $\frac{1}{4}$in.–$\frac{1}{3}$in. broad, clothed beneath with compact yellow tomentum, margins entire or crenate. Scapes 2in.–3in. high, slender, bracts acute, spreading, clothed with fulvous tomentum. Heads much smaller than in the type.

Hab. South Island: Mount Stokes. *P. A. Macmahon!*

A smaller and less robust plant than the typical form, with much narrower leaves, and sometimes densely tufted. In the type the leaves are often broadly-ovate. *C. hieracifolia* is a remarkably local species, which until the discovery of this form on Mount Stokes was supposed to be restricted to one or two localities in the Provincial District of Nelson; so that the extension of its range is of considerable interest.

C. parva, n.s.

A small densely-tufted species. Leaves, including the petiole, 1in.–$1\frac{1}{2}$in. long; petiole broad, membranous, tomentose; blade linear-lanceolate, acute, scarcely denticulate, rigid but scarcely coriaceous, white, with appressed tomentum below; margins sometimes revolute; midrib obvious beneath. Scape $1\frac{1}{2}$in.–3in. high, extremely slender, naked, or with 2–4 narrow-linear bracts, with dilated bases. Head small, involucral bracts numerous, narrow-linear, acute, outermost chaffy, sparingly pilose, with distinct midrib: rays narrow: achenes hispid.

Hab. South Island: Heaphy River. *J. Dall!*

A curious little plant, scarcely larger than the common daisy, and nearly related to *C. spectabilis*. Hook. f.

C. longifolia, Cass., var. **alpina.**

Much branched from the rootstock, branches very short. Leaves 1in.–$1\frac{1}{2}$in. long, $\frac{1}{20}$in.–$\frac{1}{16}$in. wide; petioles with a few scattered hairs, blade narrow-linear, margins clothed with white tomentum beneath slightly recurved, midrib prominent beneath. Scapes 2in.–$2\frac{1}{2}$in. high, strict, with several almost filiform bracts. Head less than $\frac{3}{4}$in. across. Involucral bracts linear-acuminate. Achenes glabrous.

Hab. South Island: In mountain-swamps, Mount Arthur, *W. H. Bryant!* Amuri, *T.K.* Canterbury, Arthur's Pass, &c., *T. K.*

C. adamsii, n.s.

Leaves 5in.–12in. long, including the petiole, ½in.–¾in. broad, membranous but firm, narrow oblong-lanceolate, sparingly denticulate, nearly glabrous above, white with loose tomentum beneath, midrib prominent beneath; petiole ¼in.–⅓in. the length of the blades, cottony, grooved. Scapes 6in.–15in. long, slender, often flexuous, more or less clothed with loose tomentum; bracts few, short, acute. Heads 1in.–1½in. across. Achene glabrous.

Hab. North Island: Kaueranga Creek; *T. K.* Whakairi, 2,000ft.; *J. Adams* and *T. F. Cheeseman*. Castle Rock, Coromandel; *T. F. Cheeseman*.

In April, 1869, I collected this plant in small quantity far up the Kaueranga Creek, but owing to the advanced period of the season the specimens were in such poor condition that the plant could only be recorded in my account of the botany of the Thames Goldfield as *Celmisia* sp.* In 1882 Mr. Adams discovered the plant on Whakairi, † higher up the creek, when I attached the specific name under which it is now described. Still more recently it was found by Mr. T. F. Cheeseman at Whakairi and Castle Rock, Coromandel, and I am indebted to his goodness for excellent specimens.

It is a very distinct species, allied to *C. graminifolia*, Hook. f., and *C. monroi*, Hook. f., with leaves intermediate between *C. densiflora*, Hook. f., and *C. discolor*, Hook. f., but more membranous than either. It bears exactly the same relationship to *C. longifolia* that *C. chapmanii* bears to *C. vernicosa*.

C. rutlandii, n.s.

Leaves with the grooved petioles 5in.–9in. long, 1in.–2½in. broad; petioles shorter than the blade, broad, clothed with snow-white tomentum, blade broadly ovate-lanceolate, acute or slightly acuminate, silvery beneath, margins entire or denticulate, midrib and lateral nerves obvious. Scapes erect, 6in.–10in. high, hoary, bracts numerous, linear-acuminate, purplish. Heads 1in.–1½in. across; involucral bracts narrow, linear-acuminate, the outer cottony; rays many; achenes silky; pappus brown.

Hab. South Island: Mount Stokes. *P. A. Macmahon!*

A handsome species, allied to *C. petiolata*, Hook. f., from which it differs in the white tomentum of the short petiole, the acute broad leaves with their silvery undersurface, and the more numerous and chaffy involucral bracts.

---

* Trans. N.Z. Inst., vol. ii. (1869), p. 97.

† Trans. N.Z. Inst., vol. xvi. (1883), p. 386, and vol. xvii., p. 378.

I take this opportunity of acknowledging my indebtedness to Mr. Rutland, whose name is attached to this handsome plant, for his ready and continuous assistance in elaborating the botany of portions of the Nelson and Marlborough Districts.

Art. XL.—*A Revision of the New Zealand Gentians.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 28th November, 1894.*]

Plates XXVII.–XXVIIc.

The first gentians observed in New Zealand were discovered during Cook's second voyage (1772–73), and were described by Forster as *G. montana* and *G. saxosa*. In 1839 Grisebach described a third species in his "Genera et Species Gentianeæ," under the name of *G. pleurogynoides*, which was reduced to a variety of *G. saxosa* by Sir Joseph Hooker in his original "Flora of New Zealand," but allowed specific rank in the "Handbook of the New Zealand Flora." In 1844 Hooker described two other species, *G. grisebachii* and *G. bellidifolia*, in "Icones Plantarum." The former was reduced by him to a variety of *G. montana*, while the latter was referred to *G. saxosa*. In the "Flora Antarctica" (1845) the learned author figured two additional species, *G. concinna* and *G. cerina*, while a form of the latter was described by Hombron in the Botany of the "Voyage au Pôle Sud" (1848), under the name of *G. campbellii*, although really found on the Auckland Islands. In 1871 Mr. J. F. Armstrong published a form of *G. montana* under the name of *G. novæ-zelandiæ;* and in 1880 Mr. J. B. Armstrong described the typical form of *G. saxosa*, a purely littoral species, as *G. hookeri*, a name appropriated by Grisebach for a South American plant in 1839. In the following account five new species are described, and *G. bellidifolia* is restored to specific rank.

In the "Flora Australiensis" Bentham united *G. pleurogynoides* and *G. saxosa* under *G. montana*, treating *G. saxosa* as a variety. The learned Baron Von Mueller unites the three forms under *G. saxosa* in his "Second Systematic Census of Australian Plants," and is supported by Sir Joseph Hooker in the recently-published "Index Kewensis." Notwithstanding all my respect for these illustrious authors, the propriety of this course seems to me at least doubtful. While fully

admitting that all the New Zealand species are closely related to *G. montana*, long-continued observation of these plants in the recent state has convinced me that they may be distinguished without any great amount of difficulty. Further, it must be held doubtful whether the true *G. saxosa* has been found in Australia. I have seen no Australian specimens, and, in my opinion, it could not possibly be included under the description of *G. montana*, var. *saxosa*, in "Flora Australiensis," iv., 373, of *G. saxosa* in Baron von Mueller's "Key to the System of Victorian Plants," 357, nor of *G. saxosa* in C. Moore's "Handbook of the Flora of New South Wales," 311, all of which agree in ignoring the remarkable calyx of the New Zealand plant. It may possibly be found on the southern coast of Tasmania, but the probability seems to me extremely small. Under the description of species (p. 338) I have tried to account for this strongly-marked plant having been confused with others, and will only add that, even if *G. montana* and *G. pleurogynoides* should ultimately be found inseparable, *G. saxosa* must always be maintained as a distinct species.

A genus so widely distributed must necessarily comprise a large proportion of variable species, but the New Zealand forms are remarkable for the excessive amount of variation exhibited by several. Not only does it affect the habit, stature, branching, texture, and inflorescence as well as the shape and size of the flowers, but it extends to the reproductive system: both calyx and corolla vary greatly in the depth to which they are divided, and in the outline of the segments, while even the form and position of the ovary are affected in some instances: the typical form having the ovary sessile, while in a trivial variety it becomes stipitate. This variation renders it difficult to find characters sufficiently stable to warrant the constitution of species, and makes it necessary to define an unusually large number of varieties. There is evidence leading to the conclusion that hybridization is largely responsible for this condition, but to a great extent it is due to environment. A careful study of the principal forms of *G. cerina*, under natural conditions, affords a striking demonstration of the power of external conditions to modify the organs of the vegetative system. The chief facts may be briefly stated here.

The form distinguished as *suberecta* is characterized by slender suberect stems, rather distant and somewhat membranous leaves, which are scarcely glossy, but are set off by a vast profusion of attractive flowers. It is not easy to imagine anything more beautiful than a mass of this fine plant with its profuse red, purple, violet, or waxy-white flowers, the latter not infrequently variegated with longitudinal red stripes or

veins. But this state is only to be seen in sheltered situations on the hills where nutritive matter is abundant and the plant has a sufficiency of saline moisture without being saturated by heavy spray.

In forma *cerina* the stems are more robust, trailing or prostrate; the leaves are large, fleshy, and shining; while the flowers are but sparingly produced, are of small size, and somewhat hidden amongst the luxuriant leaves. This form is found only amongst rocks often washed by waves, and constantly subjected to heavy spray. If growing a few feet above the actual reach of the waves, but still subject to heavy spray, the prostrate branches are much shorter, the glossy leaves are more closely set, while the flowers are larger and more brightly coloured.

In forma *concinna* the stems are short and crowded, never exceeding 3in. in length; the leaves are small and close-set, with solitary minute axillary purple or white flowers in the uppermost axils. Charming compact little specimens less than 1in. in height may often be found bearing scores of minute flowers, which are but rarely brightly coloured. This form is found chiefly on the surface of huge masses of *Trichocolea tomentella* and other Hepaticæ, often in vast abundance, in situations sheltered by a close scrubby growth of various shrubs and trees, but still exposed to the finely-divided sea-spray which constantly impregnates the atmosphere of the Auckland Islands. Hence its annual duration, diminutive size, crowded branches, close-set leaves, and minute flowers are chiefly due to a lack of mineral constituents in its nutriment, and possibly, at certain times, to a lack of moisture also.

All these forms are connected by a series of insensible gradations, so that it is impossible to say at any given point in the series, "Here is a line of division." The change is so gradual that, although it can be easily made out, it is impossible to say where one form begins and another ends.

All the New Zealand species agree in having a five-cleft calyx, a monopetalous corolla more or less deeply divided into five segments which are never barbed, five epipetalous stamens with small versatile anthers, and one-celled two-valved many-seeded capsules.

Their local distribution is somewhat remarkable, as they are not represented in the extreme northern part of the colony, their limit in that direction being attained on Hikurangi, a little to the north of the 38th parallel, from whence they extend southward to the Chatham Islands, Stewart Island, Antipodes Island, the Auckland and Campbell Islands, but do not reach Macquarie Island, thus illustrating the law previously observed in the Northern Hemisphere that, although plenti-

ful in elevated regions of both temperate and tropical zones, even reaching the snow-line, upwards of 16,000ft., they become rare or absent in higher latitudes. Generally the New Zealand forms are restricted to alpine or subalpine situations, but *G. saxosa*, *G. cerina*, *G. antipoda*, and *G. antarctica* descend to the sea-level, and are never found out of the reach of sea-spray, the first named being restricted to Foveaux Strait, the others to the Antarctic Islands. *G. montana*, *G. bellidifolia*, and perhaps *G. pleurogynoides* are found in the North Island, the first extending from the East Cape southwards to Stewart Island, the second only to Otago, the third to the Chatham Islands and Otago; and the remaining three species are restricted to the South Island, two of them being remarkably local. All the species appear to be endemic except *G. montana*, *G. pleurogynoides*, and *G. bellidifolia*, which are also found in Tasmania and the southern part of Australia.

Bearing in mind the extreme rarity of white-flowered gentians in other countries, it is remarkable that all the local species primarily produce white flowers, although *G. antipoda*, *G. cerina*, and *G. antarctica* var. *imbricata* exhibit also various shades of red, purple, and violet, or occasionally white with vertical streaks of red: the other species are pure-white, or rarely exhibit a pale-lemon or sulphur tinge, which, however, never merges into a true yellow, such as that of *Gentiana lutea*, or the common buttercup. Sometimes, however, this very pale tint becomes greatly intensified in herbarium specimens, and has led to the erroneous idea that some of the New Zealand gentians have yellow flowers.* Dr. Jameson, in his "Botanical Notes on the Flora of the Andes of Peru and Columbia," † remarks, "Of sixteen species of gentian with which I am acquainted, one-half are red, four purple, two blue, one yellow, and one white," thus offering a strong contrast to the New Zealand species, all of which are primarily white.

In the following descriptions an attempt has been made to differentiate the more striking permanent departures from the typical form of the species as varieties, but the success attained is less complete than could have been wished, although possibly sufficient has been done to prevent that sense of confusion which often troubles the minds of young students on finding a number of apparently dissimilar plants united under a common name.

---

* A parallel to this curious change of colour in dried gentians is afforded by certain white-flowered veronicas, notably *V. elliptica*, *V. vernicosa*, *V. macrocarpa*, some forms of *V. salicifolia*, &c., which, after being placed in the herbarium, sooner or later assume a purple tint.

† "Flora Antarctica," i., 55.

A. *Cauline leaves few, sessile.*

1. **Gentiana lineata**, n.s. Plate XXVII.

Perennial; densely tufted, much-branched from the root-stock. Leaves radical, $\frac{1}{2}$in. long, $\frac{1}{30}$in. broad, narrow linear-lanceolate, acute, narrowed into a flat petiole. Scapes 1in.–2in. high, naked or with one or two pairs of short linear leaves below the middle, 1-flowered. Calyx divided nearly to the base, segments linear-subulate, acute or acuminate; corolla divided fully two-thirds of its length, segments acute; ovary sessile.

Hab. South Island: Hollows on the crest of the Longwood Range, Southland (1887); *T. Kirk.*

A curious little plant, in some places forming a compact sward. Its nearest ally is *G. montana*, Forst. It is perhaps the most easily recognized of all the New Zealand species.

2. **G. montana**, Forster. Prodr., n. 133.

Annual; stems numerous or few, decumbent or suberect, 3in.–18in. long. Leaves usually distant, lower spathulate or oblong-spathulate, cartilaginous, obtuse, narrowed into petioles as long as the blade; cauline ovate or oblong, sessile or shortly petioled. Flowers usually numerous, on slender spreading pedicels 1in.–6in. long. Calyx lobes narrow linear-subulate, acuminate; corolla divided half-way down, segments subacute; ovary sessile or rarely stipitate. A. Rich, Fl. Nov. Zel., 203; R. Br., Prodr., 450; Willd., Sp. Pl., i., 1334; A. Cunn., Precurs., n. 399; Raoul, Choix, 44; Grisebach in DC., Prodr., ix., 99. Hook. f., Fl. N.Z., i., 178; Fl. N.Z., i., 271; Handbook N.Z. Fl., 290. Bentham, Fl. Austr., iv., 373 (*partim*).

Hab. Chiefly in mountain districts from the East Cape to Stewart Island. Descends to sea-level in Canterbury and Otago. Ascends to 3,500ft.

Forma typica. Stems prostrate or suberect, wiry, much-branched. Flowers numerous.

Forma *grisebachii*. Stems erect or suberect, slender, sparingly branched; ovary often stipitate in this form. *G. grisebachii*, Hook. f., in Ic. Pl., t. 636.

Forma *novæ-zelandiæ*. Slender, 1in.–5in. high, leaves more numerous, ovate-spathulate. *G. novæ-zelandiæ*, J. F. Armstrong in Trans. N.Z. Inst., iv. (1871), 291; "Index Kewensis," i.

Hab. North Island: Ruahine Range. South Island: Waimakariri, Rangitata, &c.; chiefly in damp situations.

The above forms pass into each other by insensible gradations. The last is merely a temporary state, most plentiful in moist seasons.

3. **G. spenceri,** n.s. Plate XXVII. A and B.

Annual; stems erect, very slender, 3in.–7in. high. Leaves rosulate, broadly ovate-spathulate, about 1in. long, narrowed into short petioles, obtuse or rounded at the apex; cauline leaves narrow oblong-spathulate, petiolate. Flowers in 2–4-flowered lateral or terminal involucrate umbels, pedicels short. Calyx equalling or exceeding the narrow corolla, segments ovate-oblong, obtuse or subacute; ovary sessile. Leaves of the terminal involucre ovate, petiolate.

Hab. South Island: Mount Rochfort; 2,000ft.; *Rev. F. H. Spencer!* (1880).

I have only seen two specimens of this curious plant, both of which are too far advanced to be quite satisfactory; but, after waiting fourteen years in the vain hope of obtaining better material, I venture to publish it as a distinct species, chiefly on account of the petiolate involucral leaves and small flowers with calyx teeth fully equalling the corolla.

4. **Gentiana pleurogynoides,** Griseb. Gen. et Sp. Gent., 236 (*Emend.*).

Annual, erect, slender or robust, 6in.–18in. high. Radical leaves 1in.–3in. long, petiolate, ovate-spathulate or oblong-spathulate or lanceolate, obtuse or acute; cauline few, sessile. Flowers usually less than $\frac{1}{3}$in. diameter, in terminal cymes or umbels. Calyx divided from one-third to two-thirds of its length; segments usually acute, divergent, shorter than the corolla; ovary shortly stipitate. D C., Prodr., ix., 99; Hook. f., Handbook N.Z. Fl., 190.

Hab. South Island. Common.

Var. **umbellata.**

Much-branched from the base; radical leaves oblong or ovate-spathulate; cauline sessile, broad. Flowers in terminal or lateral umbels; pedicels slender; calyx segments acute or obtuse; ovary almost sessile.

Hab. South Island, D'Urville Island (sepals acute), Chatham Islands (sepals obtuse).

Var. **rigida.**

Root stout, usually simple; stems erect, simple, or rarely branched, stout. Leaves 1in.–3in. long, narrow oblong-spathulate, obtuse; cauline in one or two pairs, smaller. Flowers forming a narrow terminal corymb. Calyx campanulate, segments very short, narrow-linear, acute, divergent; ovary stipitate.

Hab. Mountains of the South Island; common; 2,000ft.–4,000ft.

5. **G. corymbifera,** n.s.

Perennial; root as thick as a man's finger; stems one or more, erect, robust, 12in.–18in. high, naked. Leaves all radical, 3in.–6in. long, oblong or narrow oblong-spathulate, petiolate, coriaceous or fleshy. Lower bracts 2in.–3in. long. Flowers large, in broad densely-crowded corymbs; pedicels winged; calyx tubular, erect, cleft for half its length, segments shortly deltoid acuminate, shorter than the corolla; ovary stipitate. *G. saxosa* γ, Hook. f., Handbook N.Z. Fl., 191.

Hab. South Island; mountains of Nelson and Canterbury; 2,500ft.–3,500ft.

Sir Joseph Hooker pointed out the remarkable calyx of this plant in the Handbook, but placed it under *G. saxosa*, Forst. The immense compact corymbs, from 5in. to 12in. in diameter, at once attract attention to this fine plant, which is much larger than any other New Zealand species.

6. **G. bellidifolia,** Hook. f. In Hook. Icon. Pl., t. 635.

Perennial; radical leaves rosulate, spathulate or ovate-spathulate, petiolate; cauline few, ovate, sessile. Stems few or many, ascending, 1in.–3in. long, 1–3- or 5-flowered. Calyx one-third the length of the corolla, cleft for half its length, subacute, rarely acute or obtuse; ovary shortly stipitate; style very short; stigma broad. *G. saxosa* α, Hook. f., in Handbook N.Z. Fl., 191.

Hab. Mountain districts from the East Cape to Otago; 1,500ft.–4,500ft. Most frequent in the South Island.

Single-flowered specimens of this form sometimes offer a transition to var. *pulchella*.

Var. **patula.**

Stems numerous, 6in.–18in. high, shortly decumbent, spreading. Radical leaves oblong-spathulate; cauline oblong, sessile. Flowers large, in few-flowered terminal umbels or trichotomous cymes, or corymbs. Calyx deeply divided, segments linear-oblong or lanceolate-oblong, acute or subacute. *G. saxosa* β, Hook. f., in Handbook N.Z. Fl., 191.

Hab. South Island: Nelson to Otago. Common in the mountains; 1,500ft.–3,500ft.

Var. **pulchella.**

Stems erect, slender, 3in.–6in. high. Radical leaves ovate-spathulate or narrow oblong-spathulate; petioles slender, exceeding the blade; cauline few, sessile. Flowers in terminal, involucrate umbels, rarely terminal, or the lower cymose. Pedicels exceeding the leaves. Calyx half the length of the corolla; sepals oblong, obtuse or subacute.

Hab. South Island: Arthur's Pass, and other localities in the Canterbury Alps; 2,500ft.–3,000ft.

Var. **vacillata.**

Stems suberect, numerous, very slender, 3in.–4in. long, 1–3-flowered. Leaves linear-spathulate; cauline smaller, narrowed below, but not petioled. Calyx cleft nearly to the base; sepals broadly oblong, obtuse.

Hab. South Island: Canterbury Alps; *J. B. Armstrong!* Otago—Mount Earnslaw; *T. Kirk.* Apparently local.

Var. **divisa.**

Stems very slender, erect, excessively divided from the base. Radical leaves obovate, membranous, petioles broad; cauline leaves short, broad, sessile or rarely broadly petiolate; pedicels narrowly winged. Flowers forming a lax, open corymb. Calyx much shorter than the corolla, cleft nearly to the base, segments linear-oblong, obtuse or subacute; corolla cleft nearly to the base, lobes rounded at the apex, broad, spreading.

Hab. South Island: Mountains of Nelson and Canterbury; *T. H. Potts! N. T. Carrington.* Apparently local.

Var. **magnifica.**

Leaves all radical, rosulate, narrow obovate-spathulate, shortly petiolate, the remains of old petioles crowded below. Scapes very numerous, 1in.–3in. long, with one or two pairs of linear bracts, having a single large pedicellate flower in the axis of each, the whole forming a globular mass 4in.–8in. or more in diameter. Calyx fully equalling the corolla-tube, cleft for two-thirds of its length, segments broadly oblong, $\frac{1}{8}$in.–$\frac{3}{16}$in. broad, subacute or obtuse; corolla deeply divided, lobes broadly rounded.

Hab. South Island: Ridges near the summit of Mount Captain, Amuri; 4,500ft.; *T. Kirk.*

A singular and beautiful form, which will probably be found to deserve specific honours. The plants are solitary, and scattered over the slope of the ridge, so that they resemble large snowballs, and attract the attention of the observer long before he reaches their habitat. No traces of leaves are visible until the plant is dug up, when the crowded remains of dead leaves at the base of the rosette, combined with the stout root, afford evidence of the lengthened period of duration enjoyed by this form. The flowers become yellow during desiccation. It is nearly allied to *G. cerina*, Hook. f.

B. *Cauline leaves petiolate.*

7. **G. saxosa**, Forster. In Act. Holm., 1777, p. 183, t. 5. Plate XXVIIc.

Perennial; stems prostrate or ascending, 3in.–5in. long, sometimes inclined to be naked above. Leaves cartilaginous or fleshy, radical rosulate, spathulate, ¾in.–1½in. long, narrowed into long petiole; cauline smaller, petiolate, sometimes distant. Flowers terminal, solitary or in 3–5-flowered cymes. Calyx about one-third as long as the corolla, or shorter; segments fleshy, subulate, recurved at the tips; corolla rotate, segments rounded; ovary stipitate. Forster, Prodr., n. 132; A. Rich., Fl. Nov. Zel., 202; Willd., Sp. Pl., i., 1357; A. Cunn., Precurs., n. 398; Grisebach, in DC., Prodr., ix., 99; Raoul, Choix, 44; Hook. f., Fl. N.Z., i., 178, *et* Handbook N.Z. Fl., 190 (in part). *G. saxosa*, var. *recurvata*, T. Kirk, in Trans. N.Z. Inst., xvii. (1884), 224. *G. hookeri*, J. B. Armstrong, in Trans. N.Z. Inst., xiii., 340 (not of Grisebach).

Hab. South Island: On maritime rocks, Dusky Bay; *G. Forster*, 1773; *A. Menzies*, 1791. Northern shore of Foveaux Strait, Ruapuke, Dog Island, Green Island, and other places in Foveaux Strait; Rarotonga Island, coast of Stewart Island; *T. Kirk*. Ascends the Bluff Hill to 800ft.; *F. W. Hutton!* Only found in situations exposed to the sea-spray.

Most closely related to *G. cerina*, Hook. f., the sepals of which sometimes exhibit a slight tendency to become recurved. It is singular that this plant should not have been observed from the time it was collected by Menzies in 1791 until it was collected by Professor F. W. Hutton on the Bluff Hill in 1873, and it is still more remarkable that although so easily distinguished it has been confused with *G. montana* and other species. Mr. N. E. Brown, of the Kew Herbarium, who has kindly compared my specimens with the types in the Liverpool fasciculus of Forster's plants recently presented to Kew, assures me that it exactly corresponds: it is well known that the fasciculi distributed by Forster are of uneven value, and it may well be that in the set originally consulted by Sir Joseph Hooker the present plant was represented by something else. Mr. J. B. Armstrong, in his description of *G. hookeri*, does not mention the recurved calyx segments, and has further confused the plant with the alpine *G. saxosa* γ of the Handbook—the *G. corymbifera* of this paper, a robust erect species which bears no resemblance to Forster's plant.

8. **G. cerina**, Hook. f. Fl. Antarctica, i., 55, t. 36.

Perennial; stems few or many, 1in.–15in. long, suberect, decumbent or prostrate, slender or stout, leafy. Leaves

usually coriaceous or fleshy, shining obovate- or spathulate-oblong or linear-spathulate; cauline smaller, ¼in.–1½in. long. Flowers on slender pedicels crowded towards the tips of the branches, sometimes forming lax corymbs, rarely trichotomous. Calyx divided nearly to the base, equalling the corolla, rarely longer, oblong or oblong-spathulate, obtuse or rounded at the apex, broad; ovary stipitate. Stems narrowly winged above. *G. concinna*, Hook. f., Fl. Antarc., i., 53, t. 35. *G. campbellii*, Hombr., in Voy. au Pôle Sud, Bot. 26, t. 31, c. Dicot.

Hab. Auckland Islands; sea-level to 900ft.

One of the most beautiful plants in the flora, the corollas varying in colour from a pure waxy white to white with a vertical red stripe, purple, reddish-purple, and violet. It is extremely variable in habit and luxuriance, according to the nature of the habitat in which it is growing. Three principal forms may be recognized:—

Forma *a, suberecta*. Stems decumbent, ascending, slender, 6in.–12in. high or more. Leaves spathulate-oblong, petiolate or rarely sessile by a broad base. Flowers usually in lax corymbs on long or short pedicels. Calyx segments broadly oblong.

Hab. Sheltered places on the hills up to nearly 1,000ft.

Forma *b, cerina*. Stems prostrate or trailing. Leaves very thick and fleshy, shining, obovate or spathulate-oblong, narrowed below, or rarely sessile. Flowers smaller, often sunk amidst the terminal leaves. Calyx segments sometimes slightly recurved.

Hab. On maritime rocks and in places exposed to heavy spray.

Forma *c, concinna*. Usually annual. Stems numerous, 1in.–3in. long, densely crowded. Leaves all linear-oblong, obtuse, ¼in.–½in. long. Flowers solitary, small, in axils of upper leaves. Calyx segments shorter than the corolla.

Hab. On masses of *Trichocolea tomentella* and other Hepaticæ.

The three forms mentioned pass into each other by the most insensible gradations, although the extremes present a wide difference. Sir Joseph Hooker agrees with me in considering it impossible to separate *G. concinna* specifically.

9. **G. antarctica**, n.s.

Annual; whole plant minutely verrucose. Stem stout, erect, excessively foliaceous, 3in.–10in. high. Radical leaves 1in.–2in. long, rather fleshy, oblong or oblong-spathulate or lanceolate, narrowed into flat petioles, 3–5-nerved; cauline smaller, oblong-spathulate, petioles short and broad, equalling the blade or shorter, membranous when dry. Flowers

crowded in much-branched slender axillary leafy cymes, each flower in the axil of and exceeded by a linear bract; pedicels short. Calyx divided nearly to the base, segments linear-oblong, obtuse; corolla small, papery, scarcely exceeding the calyx; ovary stipitate. *G. concinna* γ, *robusta*, Hook. f., in Fl. Antarc., i., 53.

Hab. Campbell Island.

Easily recognized by the pale greenish-yellow hue of the entire plant, the minutely verrucose surface of all its parts, and its excessively-branched slender inflorescence, the flowers being almost hidden amongst the crowded leaves and bracts. Sometimes it is reduced to a broad rosette of leaves with densely-crowded flowers.

Referring to this plant, Sir Joseph Hooker writes*: "The var. γ I have never found in flower, and it may prove a distinct species, though the roots are annual and its leaves are of the same nature as the larger specimens of *G. concinna*."

(?) Var. **imbricata.**

Stems 1in.–3in. high, simple, erect, rigid, leaves at base coriaceous, with a stout marginal nerve, closely imbricating, ovate or ovate-spathulate, narrowed below. Flowers solitary in the axils of the upper leaves, which are shorter and broader. Calyx divided nearly to base; segments linear-oblong, subacute; corolla longer than the calyx; ovary stipitate. *G. concinna* β, *elongata*, Hook. f., in Fl. Antarc., i., 54.

Hab. Campbell Island: *T. Kirk.*

The entire absence of minute warts, the coriaceous leaves with strong marginal nerves, and the larger flowers tend to prove that this plant is worthy of specific honours, which I refrain from awarding until specimens in a more advanced stage can be examined.

10. **G. antipoda**, n.s.

Perennial; minutely verrucose on stem, leaves, petioles, pedicels, and sepals. Stems numerous, 3in.–10in. high, decumbent at the base, erect. Leaves ¾in.–1in. long, lingulate or linear-spathulate, obtuse, ascending, rather crowded on the lowest fourth or third of the stem; cauline distant, narrower. Flowers shortly pedicellate, solitary, axillary or on short 3–5-flowered branchlets, closely appressed to the stem for the upper three-fourths of its length, forming a narrow strict trichotomous cyme. Calyx divided nearly to the base; segments linear-oblong, subacute, shorter than the corolla-tube; corolla narrow, diaphanous.

Forma *pallida*. Stems yellow, corolla white.

* "Flora Antarctica," i., 54.

Forma *rubra*. Stems red, corolla white with longitudinal red stripe.

Hab. Antipodes Island: *T. Kirk.*

The strict fastigiate habit of this plant and the lingulate leaves readily distinguish it from any other New Zealand species. Although the flowers are produced in great abundance they are not easily detected at first sight, partly from their being much obscured by the overtopping bracts, but chiefly from the peculiar coloration, the form with red stems developing white flowers vertically streaked with red, and the form with yellow stems exhibiting delicate white flowers.

EXPLANATION OF PLATES XXVII.–XXVIIc.

Plate XXVII.

Gentiana lineata, T. Kirk. Natural size.

Plate XXVIIa.

Gentiana spenceri, T. Kirk. Natural size.

Plate XXVIIb.

Gentiana spenceri, T. Kirk.

Fig. 1. Flower, enlarged.
Fig. 2. Capsule with bracts.
Fig. 3. Ovary, enlarged.

Plate XXVIIc.

Gentiana saxosa, Forster. Natural size.

Fig. 1. Flower, enlarged.

Art. XLI.—*On the New Zealand Species of* Gunnera, *L.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 28th November, 1894.*]

Gunnera, which was constituted by Linnæus in 1767, is, perhaps, the most neglected genus of flowering plants in New Zealand. The first species recorded as a native of the colony was described by Raoul in 1844, and beautifully figured in "Choix de Plantes de la Nouvelle-Zélande" in 1846. A second species, *G. prorepens*, was published by Sir Joseph Hooker in the "Flora of New Zealand" in 1853, and a third by the same author in his "Handbook of the New Zealand Flora" in 1864. No further addition was made to our knowledge of the local species until

1882, when the Rev. W. Colenso described a form of *G. monoica* which he considered worthy of specific honours, in the fifteenth volume of Transactions of the New Zealand Institute. The name of another plant, *G. hamiltonii*, was published by its discoverer in the seventeenth volume, but without description; while Mr. Colenso described a remarkable species as *G. flavida* in the following year; and in the twenty-fifth volume Mr. Petrie described his *G. "ovata,"* which unfortunately comprised two distinct plants. As showing the small amount of attention which these plants have received, it may be pointed out that, although *G. prorepens*, a common species in some districts, was published more than forty years ago, its flowers are still unknown. This neglect is due to various causes, amongst which may be enumerated the absence of the genus from large districts, especially in the populated parts of the North Island and near the centres of population in the South Island; their restriction to swampy or watery places, and their flowering in the early spring, when such places are usually difficult of access; their remarkably inconspicuous flowers, which are almost invariably hidden amongst the leaves; and especially their monœcious or dicœcious character, which renders it difficult to obtain complete series of flowers and fruit. Although the three species included in the Handbook are increased in this paper to nine, only one of these is described in a satisfactory manner, owing to the imperfect material at my command. It may, however, be hoped that this extended notice will attract greater attention to this interesting genus, and lead not only to fuller descriptions, but to a detailed account of the complicated anatomy and histology of each species.

All the species are more or less tufted, their creeping rhizomes often forming matted patches. The Chilian *G. scabra* has leaves from 4ft. to 8ft. in diameter, carried on petioles 6ft. in length; but the New Zealand species are lowly herbs, with inconspicuous unisexual flowers, which may be monœcious or dicœcious: sometimes male and female flowers are developed on the same scape, when the lower flowers are pistillate and the upper staminate; both staminate and pistillate flowers have a bract at the base of each, and a perianth of two, or rarely four, very small segments. The anthers, two in number, are sometimes destitute of filaments, and the pistillate flowers are invariably furnished with two styles, which may be elongated and almost capillary, or stouter and compressed at the base, but invariably covered with minute papillæ. The ovary is one-celled, and contains a single pendulous ovule, while the fruit is a small, fleshy drupe, white, orange-coloured, or red, with a very minute embryo and oily endosperm. In the majority of species both flowers and fruit are wholly hidden amongst the leaves, but in *G. flavida* and

others the scapes become elongated as the fruit matures, and the showy yellow or crimson drupes are elevated above the leaves. In at least one species the drupes are of different shapes at different periods of the growing-season: in the early spring the drupes are ovate or ovoid, and form a compact obtuse mass hidden at the base of the leaves; later in the season erect scapes are developed on the same plant, and produce lax pendulous clavate drupes.

All the New Zealand species are endemic, but their distribution is unequal, and it must be mentioned that *G. monoica*, found as far north as Mongonui, *G. prorepens* which finds its northern limit at the Hunua (Auckland), *G. flavida* which has not been found north of Hawke's Bay, and *G. dentata* which extends northward to Tongariro, alike exhibit a more robust habit as they approach their southern limit in Otago or Stewart Island: the remaining species except the local *G. arenaria* are restricted to the South Island, one or two being rather local. *G. flavida* and others occur most plentifully in Sphagnum bogs.

The genus comprises about twenty-five species, and is almost completely restricted to the Southern Hemisphere. Outside the New Zealand species, one is found in Tasmania, others extend to the Falkland Islands, Fuegia and other parts of South America, Central America, Juan Fernandez, the Sandwich Islands, Java, Abyssinia, and South Africa.

1. **Gunnera monoica**, Raoul. In Ann. Sc. Nat., ii., 117 (1844), and Choix de Pl. de la Nouv.-Zélande, xv., t. 8.

A slender tufted plant with creeping rhizomes, glabrous or almost strigose. Leaves reniform or orbicular, with few short hairs on both surfaces, $\frac{1}{3}$in.–$\frac{3}{4}$in. in diameter, 3–5-lobed, or crenate, or crenate-dentate only; petioles slender, 1in.–2in. long. Panicle 1in.–3in. long, very slender, male flowers above; female with few short, often crowded branches; staminate flowers sessile or shortly pedicelled, perianth of two minute narrow acuminate segments; female segments 2, acute; styles elongated, capillary. Fruits minute, spherical, forming a compact spike or panicle hidden amongst the leaves. Hook. f., Fl. N.Z., i., 65; Handbook N.Z. Fl., 67. D C., Prodr., xvi., ii., 599. *G. prorepens*, Hook. f., Fl. Antarc., ii., 274 (in note; not of Hook. f., Fl. N.Z., i., 66).

Hab. In cool, moist situations, Mongonui to Stewart Island, but often rare and local.

Var. **strigosa**, sp. Colenso. In Trans. N.Z. Inst., xv. (1882), 322.

Whole plant more hairy, especially the rhizomes and petioles, which are often strigose. Leaves sometimes crowded at the nodes.

Hab. North Island: In rather dry places, Hawke's Bay; *Colenso!* Mungaroa, Wellington; *T. Kirk.*

Var. **ramulosa.**

Stems rather stout, clothed below with the bases of old petioles. Panicle much-branched above and below; upper branches 1in.–1½in. long; drupes not seen.

Hab. South Island: Broken River, 2,600ft.; *J. D. Enys!*

(?) Var. **albocarpa.**

Rhizomes more robust, sometimes thicker than a goose-quill. Leaves larger than in the type; flowers not seen. Fruiting panicles much-branched, branches 1in.–1½in. long, lax or compact; drupes minute, spherical, milk-white, tipped with the black perianth segments.

Hab. Southland, Kew (1880), Sandy Point, &c.

This will probably prove distinct from *G. monoica;* but in the absence of flowers I refrain from raising it to specific rank. A remarkable form of this plant collected at Kew and Woodend in 1880 has erect or suberect branches 12in.–18in. long, with from 4 to 6 shortly-petioled fleshy leaves, crowded at each node.

2. **G. mixta,** n.s.

Rhizomes slender; leaves 1½in.–2½in. long, with weak scattered hairs on petiole and blade; blade ovate or slightly cordate, rounded at the apex, crenate but not lobed. Scape very slender, unbranched, exceeding the leaves; upper flowers lax, sessile or shortly pedicelled; staminate, pistillate, and hermaphrodite flowers intermixed, staminate mostly pedicellate; perianth segments 2, narrow linear-oblong, obtuse; female perianth segments 4, ovate, unequal, sometimes with two linear-oblong processes springing from the base of the segment; hermaphrodite flowers with ovate segments, alternating with two linear-oblong; filaments short, anthers apparently abortive. Fruit not seen. *G. ovata,* Petrie, in Trans. N.Z. Inst., xxv. (1892), 274 (in part), leaves only.

Hab. South Island: Otago; *J. Buchanan! A. Hamilton! D. Petrie.*

A curious plant, resembling small states of *G. prorepens,* but essentially separated by the simple, lax, subracemose scape exceeding the leaves, which distinguishes it from all other species. The flowers may be either male or female primarily, but in either case one or two of the complementary form and one or two hermaphrodite will be found on each rhachis; rarely from three to five female flowers may be found at the base, the upper being staminate. Better and more copious material is required to form a satisfactory diagnosis.

3. **G. prorepens**, Hook. f., Fl. N.Z., i., 66.

Rhizomes rather stout; leaves 3in.–5in. long, ovate or ovate-oblong or rarely elliptic, rounded at the apex, margins entire or crenate; more or less clothed with scattered hairs; petioles strigose or hairy. Scapes much shorter than the petioles, wholly hidden among the leaves, strigose, stout, unisexual. Male flowers not seen. Female perianth segments 4, linear-obovate, obtuse, concave, cucullate; styles short, stout, slightly compressed. Drupes sessile or very shortly pedicelled, forming a compact spike less than an inch in length, broadly obconic, with a shallow groove at the apex, red. Hook. f., Handbook N.Z. Fl., 68; D C., Prodr., xvi., ii., 599.

Hab. In moist lowland and subalpine localities. North Island: Wairoa Falls, Hunua; *T. Kirk.* Taupo district; *Captain Gilbert Mair! Colenso.* South Island: Nelson to Southland; Stewart Island; *T. Kirk.*

The short, stout spike and broadly obconic drupes distinguish this species from all others, although the leaves of several bear a close resemblance. As in the next species, my flowering specimens are too far advanced to allow of a complete diagnosis being drawn.

4. **G. flavida**, Colenso. In Trans. N.Z. Inst., xviii. (1885), 261.

Densely tufted; rhizomes rather stout. Leaves 1in.–4in. long, blade ovate or slightly ovate-cordate, rarely elliptic, rounded at the apex, margins entire or slightly sinuate, or rarely crenate at base, glabrous or with few weak hairs on petiole; petioles and peduncles red. Scape unisexual, 1in.–4in. long, usually exceeding the leaves when in fruit. Male flowers not seen. Female, $\frac{1}{4}$in.–$\frac{1}{2}$in. long, segments 4, the two innermost ovate or oblong, ciliate at the apex; outer larger, obovate, cucullate, caducous. Drupes obconic, sessile or very shortly pedicellate, crimson or lemon-coloured, forming a lax spike, sometimes 2in. long, overtopping the leaves. *G. ovata*, D. Petrie, Trans. N.Z. Inst., xxv. (1892), 274 (*in part*), fruits only. *G. elongata*, T. Kirk, MSS.

Hab. North Island (collected by *Mr. Hill*): *Colenso!* probably not uncommon in the Taupo district. South Island: Common in Otago, Southland, and Stewart Island; *T. Kirk.* Frequent amongst Sphagnum.

Easily recognized by the red petiole and peduncles, and especially by the obconic drupes, which are usually elevated above the leaves. Mr. Colenso describes the fruiting state only. I gladly take the opportunity of expressing my thanks for one of his type-specimens: it has small elliptic leaves on filiform petioles, but, as the drupes of both are identical, I

have no hesitation in uniting the more robust southern plant with it, although elliptic leaves are comparatively rare in the latter. Exactly the same dimorphism is exhibited by the leaves of *G. prorepens*. If, however, the flowers of Mr. Colenso's plant, when discovered, should exhibit unexpected differences of sufficient importance to warrant its separation from the southern plant, the latter might be called *G. elongata*, specimens having been distributed under that name before I recognized its identity with *G. flavida*. *G. "ovata,"* as described by Mr. Petrie, consists of two distinct plants, which are here separated as *G. mixta* and *G. flavida:* the leaves belonging to the former, and the fruit to the latter. On the authority of Mr. N. E. Brown, of Kew, Mr. Petrie considers the plant mentioned at p. 68 of the Handbook, and there stated to have been discovered by Lyall in the Middle Island, and at the base of Tongariro by Colenso, to be identical with *G. "ovata";* but the plant of those observers is said to have the leaves of *G. densiflora* and the fruits of *G. monoica*, thus differing widely in both points from either of the plants included by Mr. Petrie. It is, however, extremely difficult to identify imperfect specimens of *Gunnera*.

5. G. dentata, n.s.

Rhizomes rather stout, tufted. Leaves 1in.–2in. long or more, petioles hairy or strigose at base, blade ½in. long or less, membranous, ovate-lanceolate or ovate, acute, with weak scattered hairs on both surfaces or nearly glabrous, margins dentate. Scapes unisexual, monœcious. Male very slender, slightly exceeding the leaves, flowers sessile; perianth segments linear-oblong, cucullate; anthers broad, obtuse. Female about ½in. long, wholly hidden amongst the leaves, silky at the base, spike ¼in. long; perianth segments 2, broadly oblong, obtuse, style very long, stout, much compressed at base; scape elongating in fruit 1in.–2in. high, exceeding the leaves, slender, lax or rarely short and sessile. Drupes on stout pedicels, clavate, patent or pendulous. *G. prorepens*, *β*, Hook. f., in Handbook N Z. Fl., 68.

Hab. North Island: *Colenso* (in Handbook); *Petrie*. South Island: Nelson to Southland, but often local; 1,000ft.–3,000ft.

6. G. densiflora, Hook. f. In Handbook N.Z. Fl., 68.

Rhizomes slender, tufted, monœcious, whole plant rather fleshy, glabrous or with few weak scattered hairs on the petiole. Leaves 1in.–1½in. long, ovate-cordate or orbicular-cordate, rarely cuneate at base, minutely crenate or almost serrate. Scapes unisexual, monœcious, stout, 1in.–3in. long, greatly exceeding the leaves. Male flowers on short stout

pedicels; perianth segments 2, linear-oblong-spathulate, cucullate, tips ciliate; anthers sessile, broad, slightly mucronate, ovary abortive. Female not seen. Drupes of two forms: in the early spring state narrow-ovoid on short pedicels forming short compact heads about ½in. long, wholly hidden by the leaves; later, clavate, pendulous, forming lax erect racemes 1in.–3in. high.

Hab. South Island: On blown sand, Cape Farewell, Nelson; *T. Kirk.* Seventy-mile Beach, Canterbury; *J. Buchanan!* Always littoral. I suspect that the inland plant from the Acheron and Clarence referred to this species in the Handbook belongs to *G. dentata.*

The dimorphism exhibited by the fruiting state is very remarkable, and may possibly be due to the plant being partially covered with a deposit of blown sand before the early fruit is fully formed.

Var. **depressa.**

Leaves shorter and broader than in the type, often suborbicular; scapes shorter than the leaves; drupes smaller, clavate when fully ripe. Flowers not seen.

Hab. Southland; *T. Waugh!*

7. **G. hamiltonii,** T. Kirk, MSS. W. S. Hamilton, in Trans. N.Z. Inst., xvii. (1884), 292 (name only).

Rhizome as thick as a goose-quill, tufted. Leaves forming dense rosettes 2in.–4in. in diameter, coriaceous, brown, glabrous or the petioles glabrescent, blade usually exceeding the petiole, ¾in.–1in. long, ovate, acute, gradually narrowed into a short, broad, winged petiole equalling or exceeding the lamina; margins minutely toothed, strongly nerved beneath. Scapes unisexual, monœcious(?). Male not seen. Female 1in.–1¼in. long, lower half naked, upper densely crowded; bracts large, broadly ovate, laciniate; perianth segments 4; stigma stout. Fruits not seen.

Hab. Hills near the mouth of the Oreti River, Southland; 300ft.; *W. S. Hamilton!*

Mr. Hamilton states, "The succulent leaves are extremely rich in lime and silica, and give off when old the epidermis as a grey paper; the anthers are sessile on very stout scapes, not crowded; the drupes on still stouter peduncles as thick as a goose-quill and 2in.–4in. long, bright red, almost sunk in the fleshy scape, not crowded, but occupying an inch or more of the top." A somewhat hasty search for this fine plant proved fruitless, and led me to the belief that it must be extremely rare and local. There is, however, reason to believe that it occurs in the Marsden district, Nelson.

The following are provisionally described pending the collection of further material :—

8. **Gunnera microcarpa**, n.s.

Rhizomes slender, tufted. Leaves 2in.–4in. long, petioles slender, hairy or strigose; blade about 1in. long, broadly ovate or ovate-cordate, with scattered hairs on both surfaces, crenate or crenate-lobed. Flowers not seen. Fruiting scapes 1in.–1½in. long, almost filiform, hidden amongst the leaves, bracts linear, ciliate at the apex. Drupes sessile, about the size of mustard-seeds, yellow or red; styles filiform.

Hab. Southland; *T. Waugh !*

Closely resembles *G. prorepens*, Hook. f., in general appearance, but differs essentially in the weak flexuous scapes, which are much longer than in that species, and especially in the minute drupes and filiform styles.

9. **G. arenaria**, T. F. Cheeseman. In MSS.

Rhizomes rather stout, stems clothed at base with the remains of old petioles. Leaves 1in.–2in. long, cartilaginous, glabrous except the petioles, which are sometimes coarsely pilose, blade about ½in. long, ovate or broadly ovate-cuneate, deeply crenate. Flowers not seen. Scape sessile or shortly pedunculate, forming a compact blunt head ½in. long; drupes ovate.

Hab. North Island: On sand-dunes, Waitakerei River; *T. F. Cheeseman !*

Closely related to *G. densiflora*, but differs in the larger leaves, subspherical or ovate erect drupes, and short obtuse spikes.

I am indebted to Mr. Cheeseman for specimens of this species.

In "Voyage au Pôle Sud: Botanique," ii., 76, *Gunnera magellanica*, Lam., is erroneously stated to have been collected in the Auckland and Campbell Islands.

It affords me great pleasure to express my thanks to Mr. Waugh, Curator of the Public Gardens, Invercargill, for his kindness in forwarding fruiting specimens of several species found in the plantations under his care.

Art. XLII.—*Descriptions of New or Remarkable Plants from the Upper Waimakariri.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

Ranunculaceæ.

Ranunculus monroi, Hook. f. Fl. N.Z., ii., 323.

Rhizome short, stout, clothed with the ragged bases of old petioles. Leaves all radical, subcoriaceous or almost fleshy, 2in.–6in. long or more, rounded reniform or nearly orbicular or ovate, nearly glabrous or hairy or silky, coarsely crenate or crenate-dentate, blade shorter than the sheathing petiole. Scape 3in.–12in. high, glabrous, simple or sparingly branched, 1–8-flowered, bracts entire or lobed. Flowers $\frac{3}{4}$in.–$1\frac{1}{2}$in. in diameter; sepals linear-oblong obtuse, glabrous or silky; petals twice as long as the sepals, five or more, broadly rounded at the apex, and with a deep nectarial pit; carpels forming a small rounded head, usually glabrous, keeled at the back, with a recurved filiform silky style. *R. pinguis*, Hook. f., in Handbook N.Z. Fl., 5. *R. muelleri*, J. Buch., in Trans. N.Z. Inst., xix. (1886), 215, t. 16.

Hab. North Island: Tararua Range; *J. Buchanan.* South Island: Nelson — Wairau Mountains; Tarndale; Spencer Mountains. Marlborough—Kaikoura Range. Canterbury—Mount Torlesse; Broken River, &c. 2,000ft.–6,300ft.

Var. **sericeus.**

Carpels clothed with silky hairs.

Hab. Kaikoura Range.

Var. **dentatus.**

Leaves broadly ovate or ovate-lanceolate, coarsely toothed or dentate, clothed on both surfaces with strigose ferruginous pubescence.

Hab. Kaikoura Range, Mount Torlesse, Broken River, &c.

This species is closely allied to *R. pinguis*, Hook. f., with which it was united by Sir Joseph Hooker in the Handbook of the N.Z. Flora: that species is distinguished, however, by the peduncles being thickened upwards, the sepals equalling the narrow petals, and especially by the short subulate beak with three ridges at the base. There is, however, considerable resemblance between the immature carpels of both plants.

VIOLARIEÆ.

Hymenanthera obovata, n.s.

An erect glabrous shrub 4ft.–8ft. high, with pale bark, sparingly branched, branches ascending. Leaves in the young state obovate-cuneate, 3-lobed, membranous; mature 1in.–2in. long, coriaceous, obovate or oblong, narrowed into a slender petiole below, retuse, margins slightly recurved, quite entire. Flowers not seen. Fruits as in *H. crassifolia*, Hook. f., but slightly larger.

Hab. South Island: Nelson—On limestone rocks, Graham river; Mount Owen; *T. F. Cheeseman!* On limestone rocks between Takaka and Riwaka; *T. Kirk.* Canterbury—On limestone rocks, Broken River basin; *J. D. Enys* and *T. Kirk* (1876): Ashburton Mountains; *T. H. Potts!* 2,000ft.–3,000ft.

This puzzling plant appears to be closely related to *H. oblongifolia*, A. Cunn., of Norfolk Island, the leaves of which are said to be denticulate, and of greater length. A common state of *H. crassifolia*, Hook. f., approaches our plant in some respects, but the leaves are smaller and almost sessile. The leaves of the young state of our plant show that, notwithstanding its different appearance, it has direct relationship with *H. latifolia*, R. Br. Baron Von Mueller's remarks on *Hymenanthera*, in his "Vegetation of the Chatham Islands," may be read with advantage.

LEGUMINOSÆ.

Carmichælia prona, n.s.

A small species, with prostrate stems and branchlets closely appressed to the ground, 4in.–12in. long, rarely more. Branchlets $\frac{1}{20}$in.–$\frac{1}{16}$in. broad, compressed on both surfaces. Leaves unifoliolate or pinnately 3–5-foliolate, silky, terminal leaflet much the longest, narrow cuneate-oblong, emarginate. Flowers in short dense 3–7-flowered racemes, rhachis silky, bracteoles ciliate; calyx campanulate; teeth short, acute, vexillum retuse, wings half as long as the keel. Pods $\frac{1}{8}$in. long, abruptly falcate with a short upturned beak, tumid, 1-seeded; seeds reniform, turgid, brown. Replum complete.

Hab. South Island: Lake Lyndon; 2,800ft.; *J. D. Enys* and *T. Kirk.*

The nearest ally of our plant appears to be *C. juncea*, Colenso, an erect species with slender terete branches. The pod of *C. prona* is practically indehiscent, as the valves remain firmly attached to the replum.

Onagrarieæ.

Epilobium gracilipes, n.s.

A slender, glabrous, decumbent species. Stems reddish, ascending at the tips and nodding, 3in.–5in. high. Leaves shortly petiolate, usually distant, ovate, obtuse or subacute, denticulated. Flowers 1–3 near the tips of the stems; sepals oblong, obtuse; peduncles of the mature capsule 1½in.–2in. long, capsule the same, glabrous.

Hab. South Island: Broken River basin; 2,000ft. to 2,500ft.; *J. D. Enys* and *T. Kirk* (1876).

An elegant species, closely related to *E. pedunculare*, A. Cunn. The peduncles are very short until the flowers have faded, when they elongate with great rapidity, frequently exceeding the capsule. Our plant is not included in Professor Haussknecht's splendid monograph of the genus.

Compositæ (Inuloideæ).

Helichrysum pauciflorum, n.s.

Densely clothed with white tomentum in all its parts. Stems 4in.–7in. high, excessively branched below, and woody. Branches nearly ½in. thick, with closely-imbricating, slightly recurved oblong or oblong-spathulate leaves, with rather broad bases. Heads solitary, almost hidden amongst the terminal leaves. Involucral scales scarious, sparingly silky, acute, scarcely exceeding the pedicellate florets. Achenes not seen. Pappus thickened upwards.

Hab. South Island: Craigieburn Mountains; *L. Cockayne.*

A remarkable plant belonging to the section *Ozothamnus*, and bearing the closest external resemblance to *H. grandiceps*, Hook. f., from which, however, it differs essentially in the solitary head, which is almost hidden amongst the terminal leaves, and the total absence of the conspicuous woolly bracts so characteristic of that species.

Ericeæ.

Pernettya tasmanica, Hook. f. Var. **neo-zelandica.**

The New Zealand plant differs from the typical Tasmanian form in the rather broader leaves, narrower sepals, which are minutely pubescent at the tips, and especially in the anther cells, which carry a minute dorsal awn at the apex of each.

Hab. South Island: By the Porter River, Broken River Basin; *J. D. Enys!* 2,000ft.

Boragineæ.

Exarrhena colensoi, n.s.

A prostrate plant, usually white, with appressed hairs. Radical leaves ¾in.–1in. long, forming a central rosette, narrow-

lanceolate, acute, narrowed below into a broad flat petiole. Floriferous branches 1in.–2in. long; leaves smaller, $\frac{3}{8}$in.–$\frac{3}{4}$in. long, with slender petioles. Flowers solitary in the axils of the upper leaves; pedicels short. Calyx segments narrow linear-lanceolate, shorter than the tube, acuminate; corolla-tube very long and narrow, limb broadly expanded; anthers very large, sessile or nearly so, inserted at the thickened mouth of the tube; nuts dark, polished.

Hab. North Island: Crags at Titiokura: *Colenso*, in Herb. Kew.; Handbook N.Z. Fl., 196. On limestone rocks, Broken River (1876); *J. D. Enys* and *T. Kirk*.

A remarkable plant, which has hitherto been confused with the Nelson *E. saxosa*, Hook. f., which is distinguished from our plant by its erect habit, obovate-spathulate erect leaves, slender petioles, and especially by its pendulous anthers. The anthers of *E. colensoi* are inserted on a thickened ring at the mouth of the tube, and therefore, as pointed out by Sir Joseph Hooker, "truly exserted." In this respect it is closely related to *E. micrantha*, Hook. f., but the habit is exactly that of *Myosotis antarctica*, sub-sp. *traillii*, of Stewart Island.

It affords me great pleasure to dedicate this interesting plant to the senior naturalist of New Zealand, the Rev. W. Colenso, F.R.S., &c., on the completion of the sixtieth year of his residence in the colony.

GRAMINEÆ.

Agropyron enysii, n.s.

Culms erect, slender, sparingly leafy, 1ft.–2ft. high. Lower leaf-sheaths pubescent or sparingly villous, especially on the margins, upper glabrous, leaves flat; ligule very short, abruptly truncate, erose. Spike 3in.–5in. long, nodding, narrow, often interrupted below; spikelets scarcely $\frac{1}{2}$in. long, usually 3-flowered, glumes slightly coriaceous and scabrid, outer glumes subequal, with scarious margins, very narrow, 5-nerved, the intermediate nerves obscure, abruptly narrowed into a stiff scabrid point or awn half the length of the glume, concave; flowering-glume one-third longer, 5-nerved, abruptly narrowed into a stout point one-third to a quarter the length of the glume; palea almost equalling the flowering-glume, retuse, hairy, the nerves strongly ciliate; ovary villous, styles very short; lodicules obovate-acute, glabrous. *Asprella aristata*, D. Petrie, in Trans. N.Z. Inst., xxvi. (1893), 272.

Hab. South Island: Slopes of Mount Torlesse and Broken River; *J. D. Enys!* (1877): Bealey Gorge; *T. Kirk:* 2,500ft. to 4,000ft., Southern Alps; *N. T. Carrington!* (1881).

Easily distinguished from any other New Zealand species by its narrow spikes and short spikelets. It greatly resembles large states of *Asprella gracile*, Benth. and Hook. f., in

general appearance, but is readily recognized by the pair of outer glumes, while the lodicules are not ciliated, nor are the styles naked below. The palea is almost coriaceous in fruiting specimens.

I am greatly pleased to attach the name of its original discoverer to this distinct species, if only to acknowledge the great service he has rendered to botanical science by investigating the flora of the Broken River basin and other places in the Southern Alps.

Art. XLIII. — *Description of New Grasses from Macquarie Island.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

Festuca contracta, n.s.

Tufted, erect, strict. Leaves erect, strict, 3in.–4in. long, terete or filiform; ligule 0. Panicle strict, narrow, erect, 3in. long, with one or two short branches. Spikelets shortly pedicellate, 2-flowered, ½in. long including the awn; outer glumes unequal, the longest nearly equalling the spikelets, lanceolate, 5-nerved (two of the nerves obscure in lower glumes). Flowering-glume with a short dorsal awn springing from just below the apex; palea scarcely ciliate, grain large. Glumes minutely scabrid.

Hab. Macquarie Island; *A. Hamilton!* (1894).

Originally discovered by Professor Scott, whose specimens were too immature for satisfactory identification.

Poa hamiltonii, n.s.

Culms leafy to the base of the panicle, erect, 6in.–9in. high. Leaves flat, spreading, exceeding the panicle; ligule ovate, laciniate, the laciniæ produced into long hair-like points. Panicle 3in.–4in. long, strict, narrow, lower branches 1in.–2in. long. Spikelets pedicellate, 2–3-flowered; outer glumes unequal, the outermost less than half the length of the inner. Flowers never webbed at the base. Flowering-glume narrow, lanceolate, 5-nerved; lodicules ovate-acute, grain large, cylindrical.

Hab. Macquarie Island; *A. Hamilton!* (1894).

A very distinct species allied to *P. foliosa*, Hook. f., and *P. anceps*, Forst., but distinguished from both by the leaves

exceeding the culms, the laciniate ligule, the smaller spikelets, and unequal flowering-glumes; also from *P. foliosa* by the longer pedicels, very short styles, and cylindrical grain.

It is most appropriate that this very distinct species should be dedicated to Mr. A. Hamilton, who has made such remarkable additions to the flora of Macquarie Island, and materially assisted in elucidating the general flora of New Zealand, more especially in the Hawke's Bay and Okarito districts.

Deschampsia penicillata, n.s.

A slender, glabrous plant, 3in.–4in. high. Leaves few, spreading, involute, 1in.–1½in. Culms erect, leafy to the base of the panicle; ligule ovate-acuminate, entire or divided; panicle simple, or with one or two branchlets at the base, rhachis and pedicels capillary; spikelets 2-flowered, with the rhachilla produced above the second flower, and bearing an empty glume; outer glume equalling the flowering-glume or nearly, narrow ovate-acute, 3-nerved; flowering-glume ovate, truncate, erose at the apex, 5-nerved; nerves of palea silky; stamens 3; grain free. Rhachilla silky, with a pencil of long hairs at the base of each flower.

Hab. Macquarie Island; 1894; in swamps: *A. Hamilton!*

In some respects this forms an abnormal member of the genus, as it is destitute of the dorsal awn characteristic of *Deschampsia*, a character which is, however, absent in other species usually referred to the genus. It has some affinities with *Aira*, but differs in the awnless flowering-glumes, the rhachilla being produced considerably above the second flower and often carrying an abortive glume, and especially in the free grain. I have only two small specimens of this curious little grass, which I was for some time inclined to consider a reduced state of *Deschampsia cæspitosa*, Palisot.

Art. XLIV.—*A Revision of the New Zealand Species of* Colobanthus, *Bartling.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

Plates XXVIIᴅ. and XXVIIᴇ.

All the New Zealand species of *Colobanthus* are glabrous tufted green or brown herbs, never exceeding 3in. in height except when they form large uneven masses. Their texture

is soft in *C. quitensis*, *C. billardieri*, and *C. muscoides*, but all the others are cartilaginous and rigid; in many cases they present a chaffy appearance. The leaves are small, opposite, and usually linear-subulate in shape, deeply channelled on the upper surface and convex beneath: with few exceptions they are either apiculate or terminate in a long acicular point. The flowers are solitary, and may be almost sessile or carried on longer or shorter peduncles, which rarely are fully 4in. in length, white, and translucent: they are either tetramerous or pentamerous, but the petals are never developed, and the sepals may be either membranous or strongly cartilaginous, while they may equal the ovoid capsule or exceed it by one-third or even one-half: most frequently they resemble the leaves in being apiculate, or tipped with long acicular points. The filaments are flat, alternating with the sepals, and are inserted at the margin of the hypogynous disc, which is sometimes strongly developed, and at others reduced to a mere line. The ovoid capsules are one-celled, containing numerous small almost reniform seeds, which are minutely dotted. To some extent *Colobanthus* represents the northern genus *Sagina*, L., in the Southern Hemisphere: the older species were formerly referred to that genus.

Colobanthus, Bartling.

1. **C. quitensis**, Bart. In Reliq. Hænkianæ, ii., 13.

Tufted, 1in.–2in. high, soft, green, glabrous, excessively branched. Lower leaves about $\frac{1}{2}$in. long, with broad membranous bases, concave above, acute; upper $\frac{1}{8}$in.–$\frac{1}{4}$in., connate; peduncles very short, terminal. Sepals 4, ovate-oblong obtuse, the two lateral smaller than the others, one-third longer than the ripe capsule. Disc narrow. Hook. f., Handbook N.Z. Fl., 24: Phil. Cat. Pl. Vasc Chil., 27.

Hab. South Island: Nelson Mountains; Kowhai River, Canterbury; Otago.

The leaves and sepals of the New Zealand plant are rarely mucronate, but never acicular. This species is found throughout the Andes, also on Amsterdam Island, &c.

2. **C. billardieri**, Fenzl. In Ann. des Wien Mus., i., 49.

Tufted, forming large patches rarely exceeding an inch in height, flaccid, grassy. Leaves $\frac{1}{4}$in.–$\frac{3}{4}$in. long, linear-subulate, channelled above, tips acute or acicular; peduncles $\frac{1}{4}$in.–1in. long, white. Sepals 5, ovate, acute or acuminate, scarcely exceeding the ovary. Disc narrow. Hook. f., Fl. Antarc., i., 26; Fl. Tasm., i., 45; Handbook N.Z. Fl., 25: Raoul, Choix, 48; Benth., Fl. Aust., i., 161; F. Muell., Second Census Aust. Pl., 46. Phil. Cat. Pl. Vasc. Chil., 87. *Colo-*

banthus affinis, Hook. f., in Hook. Journ. Bot., ii., 410. *Spergula affinis*, Hook., Ic. Pl., t. 266. *Spergula apetala*, Labill., Pl. Nov. Holl., i., 112, t. 142; DC., Prodr., i., 395.

Hab. South Island: Nelson to Southland. Stewart Island, Auckland and Campbell Islands, Antipodes Island, Macquarie Island. Chiefly at sea-level in the South. Ascends to 3,000ft. in Nelson and Canterbury.

Var. **alpinus.**

Much larger than the type, but equally flaccid, and forming small tufts 1in.–4in. across, with spreading peduncles 1in.–4in. long. Sepals ovate-acuminate, with membranous margins, slightly exceeding the capsule. Leaves 1in.–2in. long or more, with long acicular tips.

Hab. North Island: Ruahine and Tararua Mountains. South Island: Southern Alps. 1,500ft. to 4,500ft. Also in Victoria, Tasmania, Chili, &c.

Colobanthus affinis, Hook., figured in Ic. Pl., t. 266, differs from any form of *C. billardieri* found in New Zealand in the broadly-ovate sepals only half the length of the capsule, and in the wide disc.

3. **C. muelleri**, n.s.

A rigid glabrous plant, forming small tufts $\frac{3}{4}$in.–1$\frac{1}{2}$in. high. Leaves usually recurved, broadly channelled, with short acicular tips and evident midrib, $\frac{1}{2}$in.–$\frac{3}{4}$in. long, rarely more, rigid. Peduncles $\frac{1}{4}$in.–$\frac{3}{4}$in. long, often hidden amongst the leaves. Sepals 5, ovate, abruptly narrowed into channelled points with acicular tips, about one-third longer than the capsule. Disc very narrow. *C. billardieri*, var. *platypoda*, F. Mueller, in Veg. Chatham Islands, 11. *Stellaria uniflora*, Banks and Sol., MSS. in Herb. Mus. Brit.

Hab. North and South Islands; chiefly in lowland districts. Mount Camel to Stewart Island; Chatham Islands; but often rare and local. Most plentiful on shingly beaches.

I venture to refer the plant collected by Mr. Buchanan at Mount Camel, and by Banks and Solander at Totaranui, to this species, although I have not seen specimens. It is distinguished from the preceding species by its rigid habit, and especially by the cartilaginous apiculate sepals, which are longer than the capsule.

Var. **multicaulis.**

Rigid, much-branched from the base, branches naked below. Leaves somewhat lax, spreading, linear-subulate, apiculate, about $\frac{1}{4}$in. long. Peduncles scarcely exceeding the leaves, slender. Sepals narrow-ovate, acute or mucronate, equalling the capsule.

Hab. South Island: Interior of Otago! *J. Buchanan.*

I have only a few scraps of this interesting form, picked from amongst other plants in Mr. Buchanan's herbarium.

4. **C. canaliculatus**, n.s.

A small tufted much-branched plant, ½in. high, branches spreading. Leaves patent or slightly recurved, $\frac{3}{16}$in. long, canaliculate, with stout marginal nerves, sharply apiculate. Flowers ⅛in. long, on very short stout peduncles, axillary or terminating short lateral branchlets; sepals 5, ovate, acute or subacute, equalling the capsule. Disc thickened.

Hab. South Island: Central Otago. *J. Buchanan!*

5. **C. repens**, Colenso. In Trans. N.Z.Inst., xix. (1886), 260.

A small plant forming a matted turf, branches creeping, 3in.–4in. long. Leaves about ½in. long, subulate with acicular tips, not rigid, spreading, green. Scapes slightly exceeding the leaves; sepals 4, broadly ovate, shorter than capsule, slightly margined.

Hab. North Island: Near Norsewood, Hawke's Bay.

I have not seen specimens of this, which appears to be intermediate between *C. muelleri* and *C. quitensis*. I have ventured to abridge Mr. Colenso's original description.

6. **C. brevisepalus**, n.s. Plate XXVIIe.

Tufted, rigid, ½in.–1in. high, much-branched. Leaves densely imbricated, $\frac{1}{16}$in.–$\frac{1}{12}$in. long, linear-subulate, with a broad base, concave above, rounded below, obtuse, mucronate. Flowers terminal, sunk amongst the leaves; sepals 5, narrow-ovate, convex or almost keeled, mucronate, slightly exceeding the capsule.

Hab. South Island: Mount Mowatt, Awatere; 4,000ft.; *T. Kirk.* Gorge Creek and Kurow, Otago; *D. Petrie!*

7. **C. benthamianus**, Fenzl. In Ann. des Wien Mus., i., 49.

About 1in. high, densely tufted. Leaves rigid, $\frac{1}{16}$in.–¼in. long, channelled above, with short acicular points, rounded below. Peduncles very short, flowers distinctly exceeding the terminal leaves. Sepals 5, ovate-subulate, mucronate, rigid, equalling or slightly exceeding the capsule. Disc reduced to a mere line. F. Muell., Second Census Austr. Pl., 46; C. Moore, Handbook Fl. N.S.W., 100; Phil. Cat. Pl. Vasc. Chil., 87. *C. subulatus*, Hook. f., Fl. Antarc., i., 13, and ii., 247, t. 93; Handbook N.Z. Fl., 25: Benth., Fl. Austr., i., 160. *C. pulvinatus*, F. Muell., in Trans. Phil. Vict., i., 201, and Pl. Vict., 213, t. 11. *Sagina subulata*, D'Urville, Fl. Ins. Mal. in Mem. Soc. Linn. Par. iv., 618 (not of Wimm.). *Sagina muscosa β, squarrosa*, and γ, *laricifolia*, Banks and Sol., MSS. in Herb. Mus. Brit.

Hab. South Island: "Awatere Valley and Sinclair Range; alt. 4,000ft. Otago: Lake district." (Handbook N.Z. Fl., p. 25.) Campbell Island.

The above description is drawn exclusively from Campbell Island specimens, as all the South Island specimens that have come under my notice appear to belong to the next species, *C. acicularis*, Hook. f., the leaves and sepals having longer acicular tips than those of the Campbell Island plant, the perianth of which is exactly represented by fig. 4, t. 93, in Fl. Antarc. The drawing of the Falkland Island plant shows a more slender and lax habit than is exhibited by either New Zealand or Campbell Island specimens, while it differs still further in having tetramerous flowers.

8. **C. acicularis**, Hook. f. Handbook N.Z. Fl., 25.

Densely-tufted, rigid, shining green or brown stems, 1in.–3in. long. Leaves densely imbricated, $\frac{1}{4}$in.–$\frac{3}{8}$in. long or more, linear-subulate with very long acicular points. Flowers hidden amongst the leaves, almost sessile; sepals 5, linear-lanceolate, with long acicular tips, one-third longer than the capsule.

Hab. South Island: In rocky places, Nelson to Southland; 2,500ft. to 5,500ft.

A more robust species than the preceding, from which it scarcely differs in essential characters.

9. **C. buchanani**, n.s. Plate XXVIIb.

Laxly tufted, glabrous; stems slender, 1in.–3in. high. Leaves loosely crowded, $\frac{1}{4}$in.–$\frac{7}{16}$in. long; linear-subulate with acicular points, membranous, concave above, convex beneath, patent or ascending at the tips. Flowers axillary on slender peduncles exceeding the leaves, or rarely shorter; sepals 5, narrow linear-lanceolate, acute, one-half longer than the capsule. Disc narrow.

Hab. South Island: Otago; Manuherikia Valley. *J. Buchanan!*

10. **C. muscoides**, Hook. f. Fl. Antarc., i., 14.

A soft, densely-tufted, bright-green plant, forming amorphous masses 1in.–18in. in diameter or more; excessively branched and matted. Leaves glabrous, densely imbricated, patent or ascending, $\frac{1}{12}$in.–$\frac{1}{4}$in. long, linear, obtuse, with dilated bases. Flowers on short peduncles sunk amongst the leaves; sepals 4, ovate-lanceolate, obtuse, concave, equalling the capsule; the two lateral sepals larger than the others. Disc very large. Hook. f., Handbook N.Z. Fl., 25; Decaisne, Voy. au Pôle Sud: Bot. Dicot., t. 17.

Hab. The Snares; Auckland and Campbell Islands; Macquarie Island; Antipodes Island.

As the stems become matted they give off rootlets in abundance, while the seeds sometimes germinate in the capsules, and at others are found buried several inches below the surface.

I am greatly indebted to Mr. John Buchanan, formerly of the Geological Survey Department, for having so generously placed the contents of his herbarium at my disposal.

EXPLANATION OF PLATES XXVIId. AND XXVIIe.

PLATE XXVIId.

Colobanthus buchanani, n.s. Natural size.

Fig. 1. Stem, natural size.
Fig. 2. Apex of branch, enlarged.
Fig. 3. Flower, enlarged.

PLATE XXVIIe.

C. brevisepalus, n.s. Natural size.

Fig. 4. Tuft, natural size.
Fig. 5. Branch, natural size.
Fig. 6. Apex of branch, enlarged.
Fig. 7. Leaves and flower, enlarged.

ART. XLV.—*Notes and Reminiscences of Early Crossings of the Romantically-situated Lake Waikaremoana, County of Hawke's Bay, of its Neighbouring Country, and of its Peculiar Botany; performed in the Years 1841 and 1843.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 13th August, 1894.*]

Quæ fuit durum pati meminisse dulce est.—SEN.

WE have lately heard of a "perilous passage" made across this lake in April last by a party of notables, and of other few modern crossings a short time before by travellers and visitors, as being the first attempts of Europeans to do so! Having, however, crossed it myself on two occasions more than fifty years ago—and that, too, under far more adventurous circumstances, when the place and all the interior country was wholly unknown—I have thought that a descriptive paper recording my journeys would not prove unacceptable to our Society; premising also that nearly the whole of it was written at the time.

1. My First Visit to Lake Waikare.

It was in December, 1841, that I first saw Waikaremoana. I had left the Bay of Islands (my place of residence) on the 19th of November, on board of a small vessel proceeding down the East Coast, which landed me at Wharekahika (Hicks Bay), between Cape Runaway and the East Cape. At this place I had also landed about five years before, on a missionary visit to the Maoris of these parts, so that on this occasion I was not wholly among strangers.

Having stayed a few days in this neighbourhood, and engaged five Maoris as baggage-bearers, I journeyed leisurely down the coast towards Poverty Bay, detecting not a few novelties in entomology, conchology (fossil and modern), and botany. Two common yet striking objects in particular may be mentioned, as such are not found here in Hawke's Bay—the one geological, the other botanical. The rocks in the vicinity of Hicks Bay were chiefly composed of sand and pudding-stone, the latter containing immensely large oyster-shells, some of which were petrified, and contained in their cavities very fine crystals of lime. A walk of a few miles brought me to Te Kawakawa, a village situate on the immediate seashore, under a high and almost perpendicular cliff of white clay. The cliffs here are composed of a bluish indurated clay and conglomerate, and contain marine fossils. On these shores the clayey rocks had been so acted upon by the sea as to be worn quite flat, in many places stretching out into a continuous horizontal layer of rock of nearly a mile in length. On them grew a peculiar kind of large procumbent thin Alga, which, boiled or steamed, is commonly used as an article of food by the Maoris of these parts: they call it parengo, also karengo. This plant, when dried in the sun, is made up into small lots, and sent to their friends residing in the inland districts, who send the donors potted forest-birds in return. When growing fresh and wet it is exceedingly slippery to walk on. The pohutukawa* trees here form a thick and evergreen rampart between the sea-beach and the mainland (or bases of the cliffs and hills), the roots and trunks being often laved by the flowing tide. At the north this tree attains to a much larger size. There, too, it invariably inhabits the immediate sea-shore, though generally growing singly, often grotesquely hanging in an almost pendent manner from rocky cliffs and headlands, and always adding largely to the beauty of the scene. Here, in a clayey rock near high-water mark, the natives show the impression of the foot of Rongokako, one of their illustrious progenitors

* *Metrosideros robusta.*

(or mythical prehistoric personages), the print of his other foot, made in striding hence, being near Poverty Bay, a distance of more than fifty miles. Many marvellous exploits are related of this celebrated personage. I did not (as on my former visit) go round the East Cape—a bold and high promontory, composed of indurated clay, reclining back in solemn grandeur; on its face nothing grows, owing to the continual descent of *débris* from its summit and sides; but, it being nearly high water, we struck inland through a narrow, sandy defile emerging beyond the cape to the sea-beach.

On the evening of the 9th December we reached the high bluff promontory commonly known from its appearance at sea by the not inappropriate, though quite unclassical, cognomen of Gable-End-Foreland, given it by Cook, and equally well named by the Maoris Pari-nui-o-te-ra (high cliff of the sun). This remarkable headland, of not less than 200ft. in perpendicular height, is entirely composed of white indurated clay, on whose face and sides grew not so much as a single moss or lichen, from the continual crumbling-down of the clay of which it is composed. Here, in the pelting rain, beneath this towering crag, where we could scarcely stand owing to the extreme slipperyness of the wet clayey rocks and seaweeds, we found that the tide had not sufficiently ebbed to allow of our passing onwards without hazard. As, however, the evening was drawing on, and we had still some distance to travel ere we should meet with either food or shelter, we were necessitated to make the attempt. Scrambling in some places on all-fours like a cat, and upborne in others by my faithful Maoris, I rounded this cape through the breakers, passing under a natural archway in the extreme face of the rocky cliff, and got in safety to the other side. Continuing my march I collected several species of marine Algæ that were new to me. At sunset we arrived, wet, cold, and hungry, at Pakarae, a small village containing about twelve persons, who, according to their hospitable custom, heartily welcomed us, although, as we subsequently found, they had not a scrap of food to give us, this season of the year being always the one of scarcity of cultivated vegetable food. The old chief kindly pulled up three stakes from the fence of his little city—for trees there were none in this neighbourhood—as tent-poles for my tent, and presented me with a raw dead crayfish, which I was happy enough to obtain and divide among us—six in all—as a substitute for supper. The next morning we started early—having procured a basket of kumara (sweet potatoes) for breakfast, which were kindly fetched during the night from some distance—travelling, as yesterday, by the seaside. About 5 p.m. we reached the river at Turanganui, a village in the north-west angle of Poverty Bay, and, crossing

it in a canoe, proceeded on to Kaupapa, then the residence of the Rev. W. Williams, subsequently the first Bishop of Waiapu, and arrived there by 7 p.m. quite tired.

At Poverty Bay I remained several days, and during my stay obtained specimens of several new and little-known plants. On the morning of the 20th December I once more recommenced my journey, directing my course for the first time directly into the interior. Proceeding up Turanga Valley by the river's banks, over alluvial and grassy plains, we reached the forests at the base of the first high range of hills by 2 p.m. On my way thither I discovered a few plants that were new to me. Among them were a fine aquatic Ranunculus,* with very long and fistulous petioles, nearly as stout as the barrel of a goose-quill; and, higher up, a handsome plant with copious verticillate inflorescence, large subrotund leaves, and long, stout petioles, but all its flowers had long before withered. Some of its erect flower-stalks were 2ft. high. I subsequently reared it at the Bay of Islands, where it flowered well. It is the fine *Ourisia macrophylla* of Hooker, also since found by me on the edges of watercourses at Titiokura, and in several other similar spots in Hawke's Bay. From the top of these hills the prospect is most extensive. Beneath me, as a panorama, was Poverty Bay, with its romantic headlands, while far away to the left Hikurangi (the mountain near the East Cape) hid his venerable head in the clouds. Continuing our march till near sunset, we halted for the night by the side of a small stream in a desolate wild called by the Maoris Tapatapauma. The sides of this rivulet were ornamented with fine plants of a species of large-leaved *Fagus*, which I believe to be quite distinct from a closely allied species discovered by me at Whangarei in 1839,† though both considered as one species (*F. fusca*) by Sir J. D. Hooker.

The next morning I resumed my journey. Gaining the summit of the high hill before me, I had an extensive view of the interior. Hill rose on hill (Pelion on Ossa) in continuous succession as far as the eye could reach. To the left was Whakapunake (the fabled residence of the gigantic moa), an immense table-topped hill, or rather mountain; while to the right, far away in the distance, Panekire, a peculiarly preci-

* *R. macropus*, Hook. f.

† "The leaves of the species of *Fagus* detected at Whangarei are ovate-cordate, serrate nearly to base, truncate subtridentate, number of serratures in each leaf 15–21, petioles slightly villous, leaves larger and broader than in the species found at Tapatapauma, which are rhombic-ovate, upper half of leaf serrate or sublaciniate, the apex much more truncate and tridentate, attenuated at base, serratures acuminate or mucronate, 11–13 in each leaf, petioles and whole upper surface of leaf tomentose."—W. C., MSS. ined., "Tasmanian Journal of Natural Science," vol. ii., p. 234.

pitous mountain, cast its bold outline in fine relief into the sky. This, my Maori guide informed me, was Waikare, to which place we were going. Time, however, would not permit a lengthened gaze, so, descending the hill, I proceeded on. At Hopekoko, a small stream (where we rested a while to dine on roasted potatoes), the bed at the ford was one flat block of sandstone. Having feasted with most hearty zest on our vegetable roast, and fallen into marching-order, we soon arrived at a small cataract, down which the water fell perpendicularly about 20ft. into a deep and dark basin. The only ford at this place was on the very narrow edge of the fall (composed of a single mass of rock), over which I was obliged to be carried, not daring to trust myself on that perilous and slippery path, which reminded me of Al Araf, the bridge to the Mahometan Elysium. As it was I very nearly fell, through nervous excitation, into the gloomy depth below. The water, too, above was just as deep, dark, and forbidding, shelving rapidly from the razor-back edge of the rock.* About sunset we arrived at the banks of the River Whangaroa (one of the principal branches of the River Wairoa, which disembogues into Hawke's Bay). Here I obtained two small canoes from the Maoris residing here, and paddled down the river about two miles and a half to Te Reinga, the principal village of this district. This river winds round the enormous hill Whakapunake, at the base of which the village is situated. I had often heard from time to time from the Maoris of this place, and of the abyss-like cataract in its immediate vicinity, and had long cherished a hope of one day visiting it. Tired as I now was, I wished for morning, that I might realize my desire, and gain a few more additions to the New Zealand flora. The roar of the waters during the stillness of the night had much that was soothing as well as solemn in the sound. Morning broke, and, prayers and breakfast over, I entered into a little canoe and was paddled about two hundred yards to the great bed of rock which, crossing the river, dams up the water and causes the fall. This cataract, from its situation, is exceedingly romantic, the most so, I think, of any fall I have yet seen in New Zealand. The bed of rock, or rather deposit of indurated clay, sand, and mud of a very white colour, which here obstructs the progress of the river (and

* Sometimes, in my many travellings, I have been so carried (as a child on its mother's back) over slimy, slippery tree-trunks, denuded, too, of their bark, felled and thrown across chasms and deep rivers, where the banks were densely overgrown with thick and creeping jungle. And once in the interior (on the west base of the Ruahine Range) I was in like manner carried down a very high and precipitous cliff, where there was scarcely anything to hold by, the naked feet of the mountaineer Maoris holding firmly on, like a hand, or a bird's or goat's foot.

through a narrow pass in it the water rushes), is filled with marine shells in a fossil state, although at a great distance from the sea, and at a very great height above its present level. This bed of white rock is large, being not less than 200ft. in width, and, when the river is swollen by the winter's rains, surrounded as it is by high and densely-wooded hills, the fall must present a very imposing appearance. I gained several specimens of shells—uni- bi- and multi-valve—by digging them out of the rock with my hatchet. Among them were specimens of the genera *Terebratula*,* *Voluta*, *Pecten*, *Lepas*, and others at present unknown to me. The waters fell from rock to rock three several times ere they were swallowed up in the dark eddying gulf below. The deep gloom of the river in the gorge beneath, the different hues of the dense masses of foliage on either side, the sunbeams peering downwards through the tops of the trees, the enormous bed of rock above—as white as snow, the Maoris who accompanied me perched here and there upon the same, and the little village in the background, combined together to cause an enchanting and indescribable scene, possessing powerful effect. In the height only of the fall was I disappointed. I attempted a hurried sketch, but could not do the scene before me justice; in fact, I had too many things to do at once, consequently I did nothing well. I wished afterwards, when it was too late, that I had remained a day at this place, instead of passing on post-haste in the manner I did; but then I had a long and unknown journey before me, and was also confined to time. Returning to the village, and obtaining, though with great difficulty, guides and baggage-bearers to Waikare, I again resumed my journey. Paddling up another branch of the river named Ruakituri for about a mile, we landed on the left bank. The sun, almost vertical, was intensely powerful—not a zephyr playing nor a cloud in the air, nor a tree or bush which could afford a shade anywhere at hand. Through unfrequented paths (if paths such could be termed), up and down steep hills overgrown with tall young fern,† which at this season is particularly disagreeable from the clouds of fine yellow vegetable dust (deciduous scales and hairs) with which it is loaded, and which, inhaled at every breath, causes you incessantly to sneeze, we travelled until

* "*Terebratula tayloriana*, Col. (Fossil).—Shell ovate, ventricose, very solid, smooth, concentrically and obsoletely striated, lamellar; margin apparently entire; summit of larger valve much produced, arcuated, subdeflexed, thick, very truncate; perforation large; horn or light mouse coloured; length, 2¼in.; breadth, 1½in. *Hab.* As above. *Obs.* This fine species has been named after the Rev. R. Taylor, of Waimate, New Zealand."—"Tasmanian Journal of Natural Science," vol. ii., p. 244.

† *Pteris esculenta.*

3 p.m., many times halting by the way. Having roasted a few potatoes, on which we dined, I endeavoured to cheer my companions in travel, but to little purpose.* Recommencing, however, our journey, we continued our march, through want of water, until long after sunset. Fortunately, I succeeded in finding some, by the side of which, in the open wilderness, we bivouacked, all too fatigued to care much about anything save rest. Gained nothing new in botany in the whole of this melting day's horrid march—fern, fern, nothing but dry, dusty fern all around. A river, the bed of which we descended into and crossed, ran at the depth of from 30ft. to 80ft. below the surface of the soil on either side; a coarse slate and thinly-stratified sandstone formed its bed.

The next morning, at a very early hour, we arose, and, with stiff and unwilling limbs, proceeded onwards. Want of food in great measure impelled us forward, as we had yesterday been led to suppose that we should reach the next village by night. After three long hours spent in active exertion we reached Whataroa, a small village, where we were heartily welcomed. Having breakfasted and rested awhile, we left this place, and continued our march, which, as yesterday, lay over high hills, which rose in perpetual succession before us—appearing as if they were without valleys between. The country, as we progressed into the interior, became more and more barren. A scanty vegetation of stunted *Pteris esculenta*, *Leptospermum scoparium*, *Leucopogon fraseri*, and such plants, alone existed on these dry and sterile spots, save where, in the deep precipitous glens between the hills, a clump of wood was to be found, showing their heads of foliage here and there above the level of the flat lands around like oases in the desert. The soil was dry and dusty, and principally composed of broken pumice. Towards evening, from the crest of one very high hill, I had, in looking back, a splendid though distant prospect of Hawke's Bay, and the high and rugged land bounding the same. My native guides assured me that no person could keep his footing on this elevated spot when the south wind blows—an assertion which the denuded and bare aspect of the place, together with the very stunted and gnarled appearance of the few trees and shrubs about it, seemed fully to corroborate. Bivouacked again for the night at Whakamarino, a little village on the banks of a small river.

* Here I may mention what I have not unfrequently noticed—the great difference between Maoris from the coast and those of the interior when travelling together in the hilly forests; and this also obtains (*vice versâ*) when the inland mountaineer Maoris have to travel over long, flat, sandy beaches. In the olden time no Maori ever went far from his home, save on special occasions, and then in a body.

Early the next morning I recommenced my march towards Waikare Lake, the old chief of Whakamarino accompanying me. An hour's walking brought me to Waikare-taheke, a rapid stream of about 4ft. deep, caused by the exit of the waters of the lake towards the sea, which here most outrageously tumbled over a long and sloping bed of rock. A bridge of trees (and one of the best-constructed native bridges I have ever seen) was thrown across the foaming torrent, which, though strongly secured together with the woody stems of tough climbing-plants and supplejacks from the forest, seemed as if every rush of the bounding water would carry it away. A nervous person would scarcely have hazarded himself on such a vibrating and precarious footing. The singular beauty of the spot riveted my attention for a few minutes, and I had almost determined to venture on a sketch. Passing on, we soon arrived at the village Te Onepoto, situated on a high headland jutting into the north side of the lake. The gateway was, as is often the case, embellished with a pair of huge and boldly-carved human figures, besmeared with shining red pigment, armed with spears, and grinning defiance to all comers. These were not only seen to advantage through being elevated above the horizon, but their eyes (or rather sockets), instead of being set with glittering *Haliotis* shell (according to the usual national custom), were left open, so that the light of the sky streamed through them, and this was yet more particularly manifested owing to the proper inclination given to the figures, looking down, as it were, on all toiling up the narrow steep ascent into the well-fenced village. The wind now blew so very strongly that it was not possible to cross the lake in such small and frail canoes as this people had at command, so I was obliged to halt and pitch my tent here, although it was not an easy matter to find a spot suitable, owing to the very great unevenness of the ground, its unsheltered situation, and the very high wind. It was now Christmas Eve, and here I was confined a prisoner until the 29th, spending a very unpleasant Christmas.

Whilst detained, however, I made the most of my time, and was amply rewarded with specimens of new plants, and among them were several ferns. Had I not been very anxious to prosecute my journey I might have spent a very agreeable time at this romantic and interesting place. Such, however, was not the case; the people among whom we now were had scarcely at this season any food for their own use, and, although they exerted themselves to the utmost in their endeavours to be hospitable towards me and my party, they could only allow us two scanty meals of roots and herbs *per diem*.

Although at this season harvest was about commencing in the more northerly parts of the Island, here, in those elevated

spots, it was so cold that I was often obliged to keep on my thick cloak, or walk briskly about to keep myself warm. The natives assured me that the snow lay many feet deep on these hills in the winter, and that at such seasons they kept within their houses. Their houses are large and warm, and curiously constructed to keep out the severity of the winter's cold, each being built over a large pit or trench the full size of the house. Thus a house that on the outside appears to be only 3ft. or 4ft. high is, when you descend into it, from 5ft. to 7ft. in height.

I obtained from the lake some fine specimens of *Unio*,* the only living thing, according to the natives, found within its waters. I supposed this sheet of water to be about six miles in diameter, but could only guess as to its probable size from its very irregular shape. The lake is very deep and clear, and the bottom rocky. During my stay I was often struck with the magnificence of the waves of the lake; these seemed to me to be altogether unlike in grandeur and high broken commotion to anything I had ever observed in those of the sea or ocean. Perhaps such was owing to the difference between the specific gravity of salt and of fresh water, as well as to the terrific roaring blasts that furiously rushed down the narrow mountain-gullies. The continual noise by day and night caused by the winds and the waves dashing against the high, rocky romantically-piled crags was deafening; all speech was with difficulty heard.

A peculiar sea-bird, called by the natives "tiitii," which often flies irregularly at night, making a noise resembling "tee-tee-tee-tee," rapidly uttered (whence its name), is sometimes taken in this neighbourhood in large numbers. From the natives' account, it should appear that these birds resort at certain times to the tops of the highest and barrenest hills, where the natives assemble and make fires on foggy calm nights, which fires decoying the birds thither, they are easily taken with nets. I have often heard the bird when flying at night, but have never seen one. It is, I think, highly probable that they may belong to the genus *Procellaria*—perhaps it is the species *P. cookii*.

Having been daily—almost hourly—on the watch for the

---

* "*Unio waikarense*, Col.—Shell oblong or oblong-ovate, concentrically and irregularly sulcated, subdiaphanous, inflated; anterior side produced, obtuse, slightly compressed; posterior slope keeled, sharp; base slightly depressed; umbones decorticated, flattish, much worn; primary teeth large, crested; epidermis strong, overlapping at margins, wrinkled on anterior slope; colour brownish-yellow on posterior side, shading into dusky-green on anterior, with alternate light-coloured lateral stripes; 3½in. broad, 2¼in. long. *Hab.* Waikare Lake, &c."—"Tasmanian Journal of Natural Science," vol. ii., p. 250.

wind to lessen, I had got together several small canoes, with their paddlers and balers, to take me and my party across; the largest ones would just carry four persons, two to paddle if calm, but only one to paddle and one to bale if breezy. The others only carried three; so that with our baggage it was really a difficult matter safely to arrange the little flotilla. Early on the morning of the 29th, the wind lessening, we hazarded a passage, and crossed in safety to the opposite side. I, in the biggest canoe, with two natives to paddle and one to bale, was obliged to kneel or squat in the centre of the canoe, and of course in water, which came constantly into the frail bark, with my hands one on each gunwale and in the water of the lake during the whole passage. The "ever-changing" woodland scenery appeared most lovely, as we, in our tiny canoes, wound round the bases of these everlasting hills. Wherever we could we kept close to them, so as to have them to swim to if upset. Here for the first time, far away from the immediate sea-coast, I noticed the littoral species of *Metrosideros*,* pohutukawa of the natives. It grew also in similar rocky situations close to the water's edge, and after the same irregular and diffuse manner. Parasitical on its branches, in great abundance, flourished a fine *Loranthus*,† gorgeously displaying its profusion of scarlet blossoms. I could not pass by this without securing some, although my three canoe-men were very averse to their stopping and to my landing for such a purpose. We ran our canoes on shore on a little beach at the margin of the forest, where the trees overhung the water; and soon a lot of natives who lived near by came about us, and at their pressing request I consented to spend the remainder of that day and night with them. At intervals during the day I obtained several botanical prizes and novelties, among them some *Hymenophyllæ*, which here, in these ever-humid umbrageous undisturbed solitudes, flourished in full beauty, and with them some fine specimens of that handsome tree *Ixerba brexioides*, A. Cunn., which, rare at the north (where he originally detected it), was here the common tree of these forests, and at this season abounding in flowers: indeed, from its noble appearance, with much larger leaves, I at first supposed it would prove to be a second species.

The next morning (30th) I resumed my journey, after experiencing no little difficulty in obtaining a guide over the mountains, in which service I had to enlist all my suasory powers. This point settled, we commenced ascending from the shores of the lake, passing through dense forests, chiefly composed of fine trees of *Podocarpus*, *Fagus*, and *Ixerba*.

---

* *M. tomentosa*, A. Cunn.
† *L. colensoi*, Hook. fil.

Having gained the summit of the range we found travelling easy, for in these forests, where the broad-leaved *Fagus* is the principal tree, there is but little underwood; indeed, plants generally seem as if they disliked the shade of these trees, probably, however, owing to the falling of its rather thick and dry leaves, that do not soon decay. In these woods I first found a peculiar little hexandrous plant, which proved to be a species of a very small and curious South American genus—*Callixene**—and with it a new terrestrial *Orchis*,† a pretty little plant with a single leaf bearing a long one-flowered scape. The natives had told us before we started that we might expect rain on these mountains (they having a proverb to the effect that it is never dry in these parts); and so, indeed, it came to pass. After we had proceeded for about two hours it began to pour down in torrents; no shelter being at hand, we were obliged to continue our march in the cold and pelting rain. I much regretted the state of the weather, as I had every reason to expect many new and rare plants in these elevated regions. The family of ferns presented the most lovely spectacle this day I ever witnessed. In these deeply-shaded ever-humid recesses my enchanting *Todea superba* and *Lomaria rotundifolia*‡ flourished in perfection, the densely-covered and dark-green fronds of the former contrasting so beautifully with the light-coloured, elegant, and membranaceous ones of the latter. The fronds of these ferns were grouped in ever-living circles of green, from 5ft. to 6ft. in diameter, many single fronds of either plant measuring upwards of 3ft. in length. Another new species of *Lomaria*§ I also found growing in these spots. Notwithstanding the warning of the elements, I gazed entranced upon these beautiful productions of nature, and wished much to secure good specimens. I was obliged, however, under existing circumstances, to content myself with a couple of specimens of each new species, and these, too, hastily gathered and put up dripping wet into the bosom of my wet cloak, to the very great astonishment of my native companions. A beautiful and delicate large white lichen here grew on the trees, causing, in some situations, a very striking effect. The densely-wooded mountains over which I this day passed were chiefly composed of sandstone, which showed itself in different stages of decomposition in the very numerous slips in their sides. In descending one of those recent gorges

* *C. parviflora*, Hook.

† *Adenochilus gracilis*, Hook. f.

‡ Now *Lomaria fluviatilis*, Spreng.

§ *L. latifolia*, mihi, described, with others, in "Tasmanian Journal of Natural Science," vol. ii., p. 175, but placed by Hook. f. as a var. of *L. procera*, in which, however, I cannot agree.

—which required in some places no little caution—one of my natives who carried the box containing books, testaments, &c., slipped his foot and went sliding away, until he was stayed by a friendly tree—fortunately without receiving any injury to himself; the box, however, though dovetailed at its angles, was knocked to pieces with the violence of the concussion. After a silent and persevering march of some hours through the very cold rain (for, in threading our tortuous way through the endless mazes of a trackless forest, in such weather as we now experienced we found it impossible to keep ourselves warm) we began to shiver with cold, and determined to halt and make a fire at the first sheltered spot. By the side of a rivulet at the bottom of a hill we found a deserted hovel, which, though open on all sides, offered us better shelter from the pitiless rain than we had expected to find in such a place. We hastily and roughly repaired our hut with tufts of the different big sedgy plants that grew hard by, and pitched my tent; and, throwing off our dripping garments and kindling a fire, we endeavoured to make ourselves as comfortable as we could in our present circumstances. Fortunately we had a few potatoes with us, which, not knowing how long this weather might continue, we divided, *una voce*, into three small portions, so as to afford us two meals for the morrow. The rain continuing to descend in torrents swelled our little friendly rivulet into a large stream, causing me to fear that the limited level spot on its bank on which we were now encamped would be overflowed.

Daylight the next morning (31st) found us much the same as daylight last evening left us—with water on every side. The past night was one not likely to be soon forgotten. The heavy rain and rattling hail which unceasingly poured down; the vivid lightning and hollow-sounding thunder reverberating awfully in never-ending echoes among the hills; the angry winds that furiously rushed in fitful roaring blasts through the ancient forests, rocking and creaking, and, lashing the monarchs of centuries as so many saplings of a year, stripping their "leafy honours" and cracking off their branches, hurled them to the earth; the hooting of owls and shrieking of parrots, which flew affrightedly about, seeking shelter—all united to declare, in a voice too plain to be misunderstood, the great commotion nature was undergoing—fit knell for the departing year!

The morning was most gloomy; the rain still incessantly poured, and our cold, wet, lonely, and starving situation was anything but pleasant; when, as if we wanted something more to taste of the very acme of cheerlessness, our only guide deserted us, returning to Waikare. He had intimated enough last evening to cause me to suspect him, and I had

kept a watch over him, but he easily found an opportunity of leaving us. My other natives were all from distant parts of the Island, and knew no more of this neighbourhood than myself. We were now in a dilemma; to go back to Waikare was, from there being no proper path or track, not a whit easier journey than to go forward to the next village—wherever that might be. The weather, however, confined us to our rude shelter, under which I, clad in light summer clothing, shiveringly sat, holding an old, worn umbrella over my head. Towards evening the weather moderated, and I ventured to walk a few yards among the half-drowned vegetation on the banks of the river. At night, rain still pouring down, I called the natives to council to consider what we had better do in this our exigency, so we unanimously agreed, "rain or shine," to proceed on our journey to-morrow morning, travelling by compass, and trusting, somehow or other, to find our way to some village—a determination to which we were compelled through hunger, having consumed our last scanty meal.

1842, 1st January.—Early this morning the rain ceased; but, as the heavy clouds still shrouded the face of heaven, it was just as wet from the dripping trees and rank vegetation around us in these deep valleys and dark forests as if it were still raining. We commenced our wet and cold march *sans* breakfast with perhaps a more hearty will than if we had fared sumptuously. We kept by the banks of the little stream, which we crossed and recrossed repeatedly, making our walk very unpleasant; but no one expressed a murmur. Here in these deep secluded glens I detected a few ferns that were new to me. About noon, to our very great surprise, our runaway guide overtook us, bearing a large basket of fine potatoes on his shoulders, for which he had purposely gone back all the way to Waikare in that heavy rain, "in order that we might not die from hunger." I could not but esteem and applaud the man's kind consideration and heavy toil and labour for a party of strangers, whilst I disapproved of his leaving us in the manner he did, without saying a word as to the object of his returning to Waikare. With a hearty goodwill we—all hands—turned to kindle a fire and roast potatoes. And resuming our march, our guide now going with us, we arrived in the afternoon at Ruatahuna, a small village, surrounded on all sides by the eternal forests, where we were most hospitably received. Several of the natives of this village were engaged in making and carving poukakas—*i.e.*, parrot-stands—but only used in snaring the large brown New Zealand parrot (*kaakaa*) of the natives, which is commonly eaten, though its flesh is dry and lean. Their red feathers (a few found under and about its wings and neck) are in great request

for ornamenting their chiefs' carved-headed staffs, which are also used as weapons of defence. They are also fond of taming these birds as pets and decoys, which if taken young will soon talk; but they are very mischievous, and their bite is severe. That little black pest the sandfly was here in countless swarms, owing, I suppose, to the sandy nature of the soil. I never before noticed them in such numbers at any place away from the immediate sea-coast, to the sandy shores of which they are generally confined. Their bite is most virulent just before and after rain. The natives call them *namu*.

At this village I remained several days, busily engaged with the natives, many of whom were astonished at seeing a white man. On resuming my journey, our route at first lay over high steep hills, clothed with forests to their summits, thence descending to a deep valley, where ran a rapid brawling stream of from 2ft. to 3ft. in depth. By the immediate flat banks of this river, among gigantic herbaceous ferns and underwood, decaying logs, and fallen trees (which latter seemed as if in times of severe floods to have been brought hither and stranded, and proved serious impedimenta to our progress, often causing painful wounds and bruises, from their not being seen), we travelled on, every now and then crossing the stream, which we certainly did more than fifty times. This was by no means pleasant travelling; but there was no alternative. It was here on these alluvial flats I first saw a large and peculiar species of *Lomaria* growing extensively and closely, and hiding the decaying logs and sticks.* On the

* This large, striking, and strange-looking fern was early described by me (with others, in the "Tasmanian Journal of Natural Science," vol. ii., p. 175, 1843) as *L. heterophylla*, from the curious abnormal forms of its ever-varying fronds or leaves; subsequently by Sir W. J. Hooker, in his "Icones Plantarum," vol. vii., tab. 627, 628, from specimens secured on this occasion, as *L. colensoi* (there being already a species of *Lomaria* named *heterophylla*, of which I, here at the antipodes, was ignorant). This name has again been altered by Sir J. D. Hooker, in his N.Z. Flora, to *L. elongata*, Blume; and since then it has been further referred to *L. patersoni*, Spreng., by Baker (including also *L. cumingiana*, Hook., and *L. punctata*, Blume) in his "Synopsis Filicum." This last is an Indian fern, and is well drawn, with dissections and full descriptions, by Beddome in his "Ferns of Southern India," tab. xxviii. and xxviiiA. I still, however, think our New Zealand fern to be distinct from *L. patersoni*. While plentiful in its proper inland home, it is very scarce in Hawke's Bay District. I only know of it growing in one small limited spot on the side of a hill streamlet in the Seventy-mile Bush, near Dannevirke, and rediscovered there by me in 1888, after a lapse of more than forty years, when I hailed it as an old acquaintance. The Maori name of this peculiar fern is also worthy of notice, as showing (what I have more than once called your attention to in my papers) their correct natural mode of naming plants and other things—*pakauroharoha*—literally, slightly-outstretched wing, from its broad and lax pinnatifid segments; adopted from the term given to the attitude of a shag when drying its wet wings on a tidal bank.

banks of this river I also obtained specimens of a fine arborescent fern, *Dicksonia fibrosa*, Col., which attains the height of 18ft.: its caudex is very bulky, and is composed of thick layers of fibres, resembling at first sight the fibrous interior of the husk of a cocoanut. The trunks of the larger ones were grotesquely hewn by the natives into all manner of uncommon shapes, in their cutting away their fibrous outside for the purposes of planks for their houses and stores, it being more easily worked than wood, and forming a better defence against rats. In this locality I also found a species of *Myrtus*,* a small slender tree bearing orange-coloured juicy berries, growing to the height of 10ft.–15ft. The natives spread their broad dress mats on the ground under these trees, and, shaking them, soon procure a quantity of fruit, which is very good eating; they call the tree rohutu; each berry generally contains three hard reniform seeds. Towards evening we emerged from the dense forests in which we had for some days been confined and toiling, to a large plain covered with the common fern, the first fern we have seen for several days. My natives rejoiced at the sight, vociferating loudly their being privileged to see a "koraha maori" (indigenous fernland, open country) again. Their uncontrolled joy forcibly reminded me of the rejoicing of the "ten thousand" Greeks on their again seeing the sea. We halted this evening at Te Waiiti, a fenced village situated on the banks of the river at the end of the plain. This stream is here large enough to float a moderate-sized boat; its bed is composed of ashes and other volcanic substances worn into rounded pebbles, which, though originally very light, were now saturated with water, and heavy.

The next morning we resumed our journey. Passing through a low wood we toiled up the barren, steep, and lofty hills before us. These hills are composed of broken pumice and ashes. The sun was intensely hot, and the pathways or tracks, in several places worn into deep and hollow ruts, were extremely dry and dusty, our feet, and even our ankles, being often buried in the loose and broken pumice through which we had to travel, rendering it very unpleasant, and even painful to my native companions with their naked feet. Gaining the summit of the highest hill, the view was most extensive and striking. Immediately beneath meandered the River Whirinaki, a bold brawling stream flowing quickly over its stony bed, and possessing water sufficient to float a moderate-sized boat. Beyond arose barren hills of all possible irregular shapes and heights; further still an extensive plain extended east and west as far as the eye could reach; beyond it a chain

* *M. pedunculata*, Hook. f.

of lofty table-topped hills bounded the range of vision; while here and there, far away in the extreme distance, several high and isolated mountains reared their barren heads above the horizon. On the left appeared Tauwhara, a high mountain in the Taupo district; Paeroa, and Kaingaroa, near Rotorua, presented themselves in front; while on the extreme right Putauaki, the high mountain near Whakatane on the east coast, upreared its two-peaked summit to the clouds. Here, notwithstanding the pleasurable height to which my imagination had been raised whilst engaged in contemplating the magnificence and extent of the prospect before me, it soon sank below its ordinary level on finding that not a human being dwelt in all that immense tract of country on which my eager gaze then rested. The grass grew, the flowers blossomed, and the river rolled, but not for man. Solitude all! Even the very little birds, denizens of wilds, few though they were in number, seemed (so fancy intimated) to think with me, for they flew from bush to bush around and about my path with their melancholy "twit, twit," as if wishing to have all they possibly could of the company of a passer-by. Their actions were quite in unison with my thoughts, and I feelingly exclaimed,—

"Oh! Solitude, where are the charms," &c.

Descending to the banks of the river Whirinaki, I was rewarded with the discovery of a few new plants. Crossing the stream, and by-and-by proceeding over the long plain I had seen from the top of the hill, I obtained a few more botanical novelties, of such kinds as made up the vegetation of this very desolate and sterile spot. I think I never before saw so barren a plain as this. A truly "blasted heath"; or, in the nervous language of Holy Writ, a "parched place in the wilderness; a salt land, and not inhabited." Night was now fast closing around us, so we quickened our pace, although excessively tired, in hopes of finding a few sticks wherewith to kindle a fire, for none at present appeared within ken. After some time we found some small dry scrub—manuka* —on the immediate bank of the river Rangitaiki, where we bivouacked for the night.

At a very early hour the next morning we recommenced our journey. Crossing the rapid river Rangitaiki, which at the fording-place we found to be breast-deep, and which we were obliged to cross in an oblique direction, holding firmly on to the tent-poles, that we might not be swept down by its strong current, we travelled over a country more sterile, if possible, than that of yesterday. An interminable succession

* *Leptospermum scoparium.*

of dry and barren hills of broken lava, pumice, ashes, and other volcanic matter, where the stunted vegetation was all but quite burnt up with the exceeding heat of the sun's rays (it being now midsummer), afforded but a very scanty gleaning to the botanist. I was, however, rewarded with a few new plants (their finding served richly to beguile the tedium of this day's journey). Among them were a graceful species of fragrant-scented *Dracophyllum*,* a small shrub 2ft.–4ft. in height, which grew sparingly in the little dells between the hills; and two curious and minute species of *Compositæ*, which formed dense moss-like patches on the lumps of dry broken pumice. These interesting little plants were scarcely above 1in. in height, presenting quite a unique appearance with their brown and hoary leaves closely imbricated and decussated, and terminal heads of yellow silky flowers. Here, in these sultry hollows, the insect tribes were very numerous. Brilliant *Libellulæ* darted about in every direction. I captured one fine fellow, a species of *Petalura*, dappled with burnished gold, measuring nearly 4in. in length; others, having filiform attenuated bodies, † were carmine-coloured, with elegantly-disposed lozenge-shaped golden spots; whilst others were adorned with alternate stripes of black and ultramarine. Of the beautiful genus *Buprestis* (or some very nearly allied genus) I gained several specimens. Some of them were abundant on the fragrant *Dracophyllum*, allured, doubtless, by its scent and honey. The moment, however, you attempted to take one, down to the ground it would let itself drop, as if dead. The greater number of the insects I obtained were quite new, and of genera unknown to me.

Towards evening we arrived in the neighbourhood of the Rotorua lakes. Crossing a deep bog, I discovered a peculiar little leafless monopetalous plant‡ growing in, or rather *on*, the surface of the mud. On nearing Rangiwhakaaitu, the first and southernmost lake, I was much gratified with the truly lovely appearance of a very beautiful species of *Leptospermum* —a small tree of from 15ft. to 25ft. in height—which flourished here, growing in clumps and rows as if artificially planted. These trees were literally laden with a profusion of handsome blossom, and (from there being no underwood about them, not so much as a tuft of grass) looked conspicuously charming. Another circumstance appeared to me as being singular: all were old trees of many years' growth, there not being any small or young plants of the species to be met with. I say *old* because the *Leptospermum* is a slow-growing plant. Be-

* *D. subulatum*, Hook.
† *Agrion* sps.
‡ *Utricularia protrusa*, Hook.

neath them grew plentifully a curious woolly-looking white moss, which, though I sought assiduously, I could not detect bearing any fructification. We had previously arranged to make Tarawera (the second lake, where some natives reside) our halting-place for this night; but, although we had nothing to eat, we were so excessively tired as to be obliged to bring up on the white-gravelled shores of the placid Rangiwhakaaitu. I offered my natives the choice of staying supperless where we were or of proceeding on to Tarawera, distant about three miles, and there getting supper, Fatigue, however, overcame hunger even in a New-Zealander, and they chose the former. The whole face of the country in this neighbourhood was overspread with massy blocks of compact lava scattered in every direction, many of them being vitrified on their surfaces. The ground gently rose on every side from the lake, which appeared to occupy a deep hollow, and I could but venture to suppose that this might have been the crater of that volcano which, in some bygone age, inundated the whole of the adjacent country with showers of pumice and ashes.

At an early hour the next morning we arose, feverish, stiff, sore, and hungry, to recommence our march. We soon came within sight of the place where the hot springs were situated, from which the steam and sulphurous vapours ascended in dense white clouds. The air this morning was cool and bracing, and after travelling about an hour and a half we arrived at Tarawera Lake. Here, at a little village on its banks, we gained some potatoes, on which we breakfasted with hearty zest. At this place were several small hot springs which flowed out of the earth near the margin of the lake; the water of some was hotter than the hand could bear. Just within the lake the water was warm; a little further on it was lukewarm; and further still it was cold: so that these natives have baths of every requisite degree of heat always ready at hand, without any trouble whatever. The water of the lake I supposed to be specifically heavier than the sulphurous hot waters which flowed into it, as whenever any of the natives of the village wished to drink I observed them go out into the lake, where the water was knee-deep, and, dashing the uppermost water aside with their feet, quickly take up some from beneath, or, lowering down a calabash, keeping their fingers closed over the small hole near the handle, fill it below. This water they said was good and cold. The natives of the village informed me that at a spring on a hill at a little distance the water was quite hot enough for the purposes of cooking, for which they often used it. Sulphur, too, abounded there, and was often "thrown up" out of the earth, from which place steam and smoke ever ascended. My curiosity being

excited, I, while breakfast was getting ready, set off, with a native of the village as a guide, to the boiling spring; but, after going up one steep hill and down another, and not perceiving any sign of the same, and being almost exhausted from want of food, and the sun's rays this still morning being very powerful, hunger conquered curiosity and I returned to the village. I have often been surprised at the great carelessness which I have shown towards rare natural productions when either over-fatigued or ravenously hungry: at such times, botanical, geological, and other specimens — which I had eagerly and with much pleasure collected, and carefully carried for many a weary mile — have become quite a burden, and have been one by one abandoned, to be, however, invariably regretted afterwards. Breakfast ended, we, accompanied by the chief of the village, paddled nearly to the opposite end of the lake. This sheet of water appeared to me to be about three miles and a half in length, and from one to two miles in breadth; it is surrounded on all sides by barren hills, and is very deep. Landing, and walking about two furlongs, we came to Kareha, another little lake, much smaller than the preceding. Here we were obliged to sit and wait some time before we could get a canoe, which having obtained we paddled to the opposite end. This little lake is about a mile in length, and about three-quarters of a mile in breadth. Resuming our journey, and gaining the summit of a high hill, we had a fine prospect of the principal Lake of Rotorua—a fine sheet of water, about six miles in diameter, with a very picturesque island nearly in the midst. An easy journey of a few miles from the top of the hill brought us to Te Ngae—a Church mission-station on the eastern side of the lake, where we were very hospitably received by Mr. Chapman, the resident missionary. I gained not a single botanical specimen throughout the whole of this day.

Having thus briefly narrated my return journey as far as Rotorua, I end my relation there, merely adding that I continued it on foot, and, crossing more than once from the east coast to the west coast, arrived safely at the Bay of Islands on the 22nd February, 1842.

II. My Second Early Visit to Waikare Lake.

On this occasion I had travelled up the east coast from Rangiwhakaoma (Castle Point) in company with Archdeacon William Williams (afterwards the first Bishop of Waiapu) to Te Wairoa, in Hawke's Bay. At Te Wairoa we parted company, the Archdeacon going on to his residence in Poverty Bay, and I going directly inland, to carry out the instructions of the Bishop of New Zealand (Dr. Selwyn), viz.: to take the

number and names of all the tribes, sub-tribes, and people—men, women, and children—inhabiting the unknown interior, and for this purpose, if required, to visit every village.

On Monday, the 18th December, 1843, having obtained a native guide to Waikare Lake, I left the village—Uruhou, on the River Wairoa—with my party of young natives (single men), whom I had secured at Te Awapuni (Ahuriri), to accompany me overland to the Bay of Islands.

Our course lay up the valley in a N.N.W. direction. The huge table-topped hill Whakapunake bore N.N.E. from us, distant about twenty miles. After travelling six or seven miles, during which we crossed the River Wairoa in a canoe, we arrived at the junction of the River Wairau, and bore away on its left bank for about a mile, when we crossed it in a canoe at a little village called Hinemoka, the inhabitants being ten in number. Here we dined, proceeding on west by the right bank of the river for two miles, then north-west to a small village called Iringataha, possessing one good large house; thence two miles to Kainganui, a high hill, from the top of which Panekire (the precipitous and bold high cliff overhanging Waikare Lake) bore W.N.W., Uruhou south-east, and Whakapunake north-east. Two miles further on we passed through a small village called Herepunga, to which place the chief of Iringataha accompanied me. Proceeding hence we travelled on smartly until 8 p.m., when we brought up for the night in an old deserted plantation, where we gained, by digging, a few potatoes for supper.

The next morning we did not rise early, the rain and the mosquitoes having kept us awake during the night. However, we started at 7, and at 9 reached Te Matai, a small clean village on the immediate bank of the stream Waikaretaheke, which we crossed in a canoe, and which, from the great rapidity of its current, was not a little dangerous. At this village I found about twenty-five persons, some of them from the lake. At 11 a.m. we left Te Matai, and halted at 4 p.m. to dine on the grassy banks of the Mangamauka, a small rivulet. From this place we travelled on till sunset, when we brought up for the night in a potato-plantation about three miles from Waikare, where we found a few natives. Our course this day was by the side of the River Waikaretaheke, which is little else than a continuation of rapids, from the great inclination seaward of the whole locality, and well deserves its name. Noticed several pretty waterfalls, some of great height, the water, however, scanty, often silently flowing down the bare face of an almost perpendicular cliff like a silver thread into the dark-green depths of the forest at its base. We did little more than a half-day's journey this day, owing to the disinclination of my

newly-engaged native companions to travel and the great loquacity of my guide.

The next morning, breakfast over, we set forward, two chiefs of the place going with us. Just beneath the plantation we had to cross the outrageous river, and that over a dangerous and wide rapid: the worst part of it had two trees felled and thrown on it; myself and dog had some difficulty in getting across, but eventually did so in safety. The tumbling water was very noisy, and the scene quite romantic. From this place to the lake was nearly all ascent. In about two hours we arrived there, and found the waters like a raging sea. The wind was strong from the north-west, and the noise of the tall trees in commotion and waves and water surging against the rocks was almost deafening: it was with great difficulty one could hear his own voice. Here, at Te Onepoto, a small fenced village on this immediate shore of the lake, were about forty natives: most of them, however, were from Wairau, on the opposite shore; they welcomed us heartily in their usual boisterous hospitable way.

The next morning the wind, which had been blowing furiously all night, was as strong as ever; no crossing the lake while this continues.

Friday, 22nd.—Wind still very high. A very heavy storm of hail fell to-day, which made it very cold, the hail lying on the ground for some time, giving the place the appearance of snow. A canoe came across the lake to-day before the wind (the largest I had ever seen here) to fetch potatoes. Towards evening I proposed starting, but the natives of the place were not willing to go until to-morrow. When here last, at Christmas, 1841, I was detained six days through the high winds, and I fear this will also be the case this time.

23rd.—Rose early. Found the lake a perfect calm. The natives, however, procrastinated as usual, and went at 8 a.m. to a village about a mile distant to have a *tangi* (cry over the dead) for a child lately deceased. By 10 a.m. they returned, but the wind had again begun to rise. However, I struck my tent and packed up, but by the time they had cooked food and fetched potatoes in flax baskets from their storehouses the wind had risen considerably, and the lake was quite rough. They had about forty baskets of potatoes, besides pigs, &c., as cargo, and were above twelve in number, so they well filled their canoe; and we, being eight persons, with our baggage and my dog, could not possibly enter to cross with any prospect of safety as the lake then was, so I was obliged to lose this opportunity. I sent two natives of the place with them to bring back the canoe. They were a long time in crossing; and by evening the canoe returned to us, but with great difficulty. The wind being again too strong to venture on the

lake, I was obliged to re-pitch my tent, and patiently wait for a calm. During the absence of the canoe I ascended Panekire, the high, precipitous hill which arises abruptly from the south-east side of the lake, and is conspicuous at a great distance. The prospect from the summit was extensive towards the East Coast, the Wairoa River and Hawke's Bay being quite open to view. I was disappointed in not gaining a single botanical novelty, save a small orchid of the genus *Microtis*.

24th (Sunday).—Wind very strong, and the combination of noises—from winds and trees, waters and rocks—so great and incessant that at divine services my voice was scarcely heard.

25th (Christmas Day).—Wind as strong as ever; the weather, too, gloomy, dark, and lowering. A most disagreeable day, from the thick clouds of fine dust continually blown about, of so exceedingly minute a nature as to penetrate the linen cloth of my tent. It is a curious fact that this same day two years ago I was a prisoner here from the same cause—high winds.

26th.—Wind still strong; could not venture into the neighbouring forests, fearing fallen trees and branches. Sat with three old natives in their subterranean dwelling, and conversed with them. I found that at no great period of time back two canoes at two different times had been upset on the lake, one containing six and the other eight persons, when all perished; only the body of one was found, and that was caused through the presence of mind of the unfortunate dying native, who had fastened himself to the rope of the sail.

27th.—Early this morning the wind had somewhat abated. It soon, however, recommenced blowing strongly, but only in gusts; however, I determined on starting without waiting for breakfast. I had twelve stout paddlers and the largest canoe, so we left at 7.30 a.m. It was a time of alternate hope and fear; every wave that rolled past swept partially over the gunwales of our frail bark, insomuch that one of my paddlers was obliged to be continually baling; I, of course, in water, and having much trouble with my dog, who did not like his situation at all.* At the end of two hours, by dint of constant hard paddling, we landed safely at Mokau, a small village on the opposite side of the lake. Here Tuiringa, the

* I was at an early period obliged to have a good dog to guard my tent in my absence from it, the common dogs of the natives being so very numerous, lean, hungry, and thievish, some being remarkably expert at this work. I have known more than seventy to belong to one large village, and could relate many curious adventures concerning them.

principal chief of the Urewera Tribe, resides—a venerable old man, with a flowing grey beard, who received us very kindly. He had killed a pig for us, and had been looking out big with expectation for some days, in hopes of the wind abating. Desirous though I was of proceeding on my journey after so much lost time, I was obliged to consent to spend the remainder of this day and the night here with him, as he had been somewhat offended at my not doing so on my former visit to these parts. Spent the long day in conversation with the old chief and his party. I was much impressed with the amiability of the old man—so kind, so deferential, so intelligent. I felt it to be a treat to be with him: not but that I had known others such among the natives—thinly scattered, as it were, throughout the land—but this chief possessed such a calm, lovable countenance, with great simplicity, willing to be taught, asking many questions. Ah, me! I parted from him with regret.

28th.—Rose early, and, divine service over, we paddled to Hereheretaunga, the usual landing-place where the track to Ruatahuna begins, the dear old chief and his people going with us. Arriving there, we cooked and ate our breakfast, and at 8 a.m. recommenced our journey. At sunset we arrived at Te Takapau, a village containing about thirty persons, situated in the midst of a dense forest, and close under the high hill of Ruatahuna, which gives its name to the district. The people here, who had been expecting us, having heard of us by those who had crossed the lake in their canoe on the 23rd instant, gave us a hearty welcome, and despatched messengers to Te Kotukutuku, a small village close by, and to Oputao, a large and fenced village about two miles distant, to inform them of my arrival, and before long all hands poured in to see me. I stayed several days in the Ruatahuna district prosecuting my inquiries, receiving much kind hospitality from the natives. Several of them, both here and at Waikare Lake, were now professing Christianity, and a few were able to read, books being in great request.

Here I conclude this portion of my long right-and-left and figure-of-eight journey from village to village in the then unknown interior, and several times and in different places making the beaches on the east and west coasts, finishing it at Waimate, Bay of Islands, on the 15th February, 1844, the whole distance being performed on foot.

As I had taken bearings by compass of several prominent spots, of the courses of the larger rivers, and also of my own track (wanderings), with the positions of the larger villages, I laid these down at the Bishop's request on a large blank outline map of the North Island on my return to Te Waimate, and the Bishop sent the same to England. My dotted track

in the interior, &c., was subsequently engraved by Arrowsmith in a map of the colony. I have seen a copy of that map here in Napier some thirty years ago. During the Maori war in the interior under Sir George Whitmore my original MS. map of those parts, containing my track, with the villages, and rivers with their fords, was lent by me under service to the Government, and was, I believe, copied for them.

I may also mention that I had left the Bay of Islands on this journey in a small schooner on the 13th of October, and landed at Te Kawakawa, in Hicks Bay, on the 18th of that month, in a rising north-east gale. But when I say "landed" there, I should also explain that, owing to the heavy surf, our boat was soon capsized on entering the outer breakers, and I had to swim for life,—soon, however, helped by the Maoris, who had thronged the beaches expecting the disaster. This, too, was caused by the foolhardiness of the captain of the schooner, who persisted in leaving his ship, after coming to anchor a long way out from land, he having some small cargo to land there, although warned by the big white signal flying at the newly-established mission-station that there was no communication with the shore. I had also with me those two young Maoris whom I had taken hence two years before, and who had made with me my former long overland journey, and whom I was now returning to their home and tribe. They had warned the captain, through me, that there was no safe landing there at this time, but all to no purpose. The captain saved his big boat, with mast and oars (losing many smaller things), and, returning hastily—a wiser man—to his ship, was obliged to cut cable and run away to sea. From Hicks Bay I again travelled on to Poverty Bay, as I did on the former occasion, but this time *incog.* (through want of clothing and tent and baggage, all such having been left on board of the vessel), by which, however, I learnt a little more of the Maoris.

ART. XLVI.—Phænogams: *A Description of a few more Newly-discovered Indigenous Plants; being a Further Contribution towards the making known the Botany of New Zealand.*

By W. COLENSO, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th November, 1894.*]

Class I. DICOTYLEDONS.

Order VI. CARYOPHYLLÆ.

Genus 2.* **Stellaria,** Linn.

1. *S. pellucida,* sp. nov.

A perennial, prostrate, slender, rambling, weak, flaccid, creeping herb, 12in.–18in. long, growing profusely in large beds or patches of several feet each way, rooting from nodes; stems containing one central capillary tenacious pith. Leaves dark-green, distant, opposite in pairs, suborbicular (generally broader than long), 1–2 (rarely 2½) lines diameter, apiculate, minutely punctiform with white dots, margined, margins slightly uneven with dark border (also midrib) underneath, base slightly decurrent; petioles flattish length of leaves, slender, with a few weak hairs, connate and finely fimbriate. Flowers (noticed) very few; peduncles axillary, longer than leaves, 2- sometimes 3-flowered; pedicels a little longer, sometimes unequal, with a pair of large concave scarious bracts at base, 3 lines long, and another similar pair below the middle of the longer pedicel; bracts pale, ovate-acuminate, with a dark central line. Flowers very small; petals 0; sepals 5, 1 line long, ovate-acuminate, with broad white scarious margins, 3-nerved, nerves dark-purple; styles 3, rather large, rough; capsule produced, longer than sepals, broadly ovoid, very obtuse, white, very membranous, semi-transparent, seeds visible through it; seeds large for plant, 11, oblong-ellipsoid and suborbicular, turgid with a notch, bright cinnamon-colour with darker margins, minutely muriculate (under lens).

Hab. Interior deep forests near Dannevirke, County of Waipawa; March, 1894: *W. C.*

Obs. This plant was only detected in two low-lying localities in those dense forests, where, however, it forms large closely-overgrowing beds. Small and humble though it is, it

* The numbers of the orders and genera given here are those of them in the "Handbook of the New Zealand Flora."

has given me much trouble—(1) in obtaining flowering specimens, for, though I brought away a large amount of it, gathered casually on first seeing it (being struck with its pleasing, neat, and healthy appearance), believing it to be new, I found on diligent examination that I had not a single flower among them all. So, though the distance was considerable (for me, in my then present weak state), and I had grave doubts as to my again finding the localities, I went again to those woods, and after no small amount of trouble and weariness I found the spots, and sat down and spent a long time in overhauling the beds for flowers, and at last found only a few—about seven or eight—specimens. (2.) On close, patient examination I find this plant comes next to *S. parviflora*, Banks and Sol., and also to *S. oligosperma*, mihi (Trans. N.Z. Inst., vol. xviii., p. 257), but yet possessing characters which those species have not, and its own peculiar characters are also constant.

Genus 3. **Colobanthus**, Bartling.

1. *C. cæspitosus*, sp. nov.

Plant annual, small, bushy, erect, and spreading, 2in.–3in. high, much-branched from root, dark-green, glabrous; stems and branches slender, dichotomous. Leaves few, distant, in pairs on stems 5–8 lines apart, largely connate, narrow-linear, 3–4 lines long, $\frac{1}{2}\frac{1}{5}$in. wide, aristate, rather thickish, not rigid, opaque, recurved. Flowers numerous, small, terminal 2–3 together, and solitary axillary on stems, peduncles 3–8 lines long, slender, erect, filiform; perianth 1 line long; sepals 4 (rarely 5) ovate-elliptic obtuse with broad white margins; petals 0; stamens 4, opposite sepals; styles 4–5, stigmas largely penicillate, pale; capsule a little shorter than sepals, whitish; valves 4 (sometimes 5), very broad and truncate at tips. Seeds numerous, very minute, of various shapes —broadly cuneate, subreniform-dimidiate, or semi-orbicular and gibbous, tuberculate.

Hab. On the hills at Napier, in dry spots; 1894: *W. C.*

Obs. A species having affinity with *C. repens*, mihi (Trans. N.Z. Inst., vol. xix., p. 261), and with other New Zealand species, but of a different size and habit, as well as possessing differential characters. It is also pretty closely allied to *C. kerguelensis*, Hook. f., differing in the obtuse and margined segments of its perianth, &c.

Genus **Cerastium**, Linn.

1. *C. amblyodontum*, sp. nov.

Plant annual, simple, erect, slender, 7in.–8in. high, very hairy. Leaves few, scattered, patent, pale-green; at base, 4,

small obovate-spathulate, 3–4 lines long, 1 line broad; on stem, 4–5 pairs, opposite, linear-oblong, 7 lines long, 2 lines broad, sessile, margins entire slightly sinuous, ciliate; hairs jointed acute; tip subacute; midrib wavy; veins largely reticulated; hairs on surface strigose, muricatulate, white, shining. Flowers few, 7 on each plant; in one specimen single throughout on main stem, alternate, ¾in.–1in. distant (and 2 flowers together lowest on stem, 1 of them smaller on shorter pedicel and nodding); in another specimen none on main stem but on forked peduncles at top, 3 on each peduncle with a single flower in fork at their bases; pedicels ½in. long, suberect, springing from a pair of leafy bracts with membranous margins. Sepals rough, green, subovate, much acuminate, with a strong central nerve, and very broad white shining membranous margins, with tips rounded and produced beyond sepals. Styles 5, long, penicillate, flexuous. Capsule subcylindrical, more than twice the length of calyx, whitish, smooth, shining, curved, 10-nerved longitudinally, nerves straight prominent, ending in the notches between the teeth; teeth truncate, their lateral margins regularly recurved; capsule before opening greenish, tip subacute. Seeds broadly obcordate, subturbinate, with a notch at the narrow end, brown, tuberculate, tubercles numerous, minute, black.

Hab. On Tongariro Mountain, County East Taupo; 1893: *Mr. H. Hill.*

Obs. A rather curious though humble plant; it sprang from turfs (see *Sagina*, the following plant), and was for some time overlooked by me (supposing it to be one of our cosmopolite British species, very common here) until after flowering, when it showed its extra-long shining white capsules; then, on examining it, I found several grave and peculiar characters, mentioned in description, particularly its strongly-nerved capsule, truncate teeth with recurved lateral margins, and curiously veined leaves with midrib deflexed. This very peculiar character is found in all its leaves. Its petals (if any) had fallen away, also stamens, but on one unripe capsule the five styles were perfect. In all the drawings with dissections (and descriptions) I possess of many species of *Cerastium* (Sowerby's, Hooker's, &c.) the teeth are always shown to be very acute, and the capsule cylindrical and nerveless. It may not be amiss for me to call the attention of the botanical student and scientific reader of this description to another and somewhat similar indigenous species—*C. truncatulum*—also having peculiar broad truncate teeth, which, however, are cloven, described by me in a former volume of Trans. N.Z. Inst. (vol. xxv., p. 327).

Genus **Sagina**, Linn.

1. *S. truncata*, sp. nov.

Plant small, perennial, tufted, grass-green, 1in.–1½in. high; branches 3in.–5in. long, slender, procumbent, creeping, rooting at nodes; leaves—of tufts, numerous, very close, suberect and spreading, linear aciculate, 9 lines long, scarcely ½ line wide; of branches, much shorter, 5–7 lines long, subfasciculate, 5–8 together at nodes, subsecund, the outer pair connate, 5–8 lines apart on stems. Perianth 1 line long; sepals 4, oblong-ovate, obtuse, concave, equal, green; petals 4, often 0, very short, oblong obtuse, subhyaline, alternate with sepals; stamens 4, opposite sepals, slender, capillary, erect, at first longer than capsule; anthers orbicular, white. Styles 4, short; stigmas long, recurved, roughish subpenicillate, hairs (under lens) knobbed. Capsule suborbicular, longer than sepals, tip produced, sub-4-angled, opening by 4 valves, their tips very truncate; pale-green at first, whitish when ripe. Seeds numerous, pear-shaped, brown, roughish.

Hab. On Mount Tongariro, County of East Taupo; 1893: *Mr. H. Hill.*

Obs. I. This species certainly has close affinity with *S. procumbens*, Linn., which in some characters it resembles (*primâ facie*), an Australian and British plant; differing, however, in its leaves being much more numerous, fascicled 5–8 together at nodes (in that species only in pairs), and in their being aciculate, and subsecund on branches; in its flowers being always erect, not nodding, and mostly terminal; its petals, when present, very minute, smaller and of a different shape and structure; in the form of its capsule; and in the tips of the valves being very truncate, almost emarginate. I have closely examined it (living specimens), comparing it with drawings and dissections given by Sowerby and by Hooker, and descriptions by them and by Bentham (Australian specimens), and note the differential characters.

II. This little plant has almost a history. Mr. Hill brought it (possibly unnoticed) in a turf-like lump of earth with other very small plants; these were all crushed, withered, and apparently dead through long and close keeping and rough carriage, but I set them in a flower-pot, and last summer this one flowered, but the flowers were all eaten up by snails and slugs in one night before they were fully developed; so I had to wait till December in this year (1894), and the plant has flowered plentifully. In not more than 1 in 10 perianths have I found any petals.

[This genus, and the one preceding it, *Cerastium*, are not found in the "Handbook of the New Zealand Flora," but they both belong to this order, and are closely allied to *Colobanthus*.]

Order XXXIX. Compositæ.

Genus 1. **Olearia**, Moench.

1. *O. multiflora*, sp. nov.

A low much-branched close-growing shrub, 2ft.–3ft. high and 2ft.–3ft. diameter; branchlets bark, dull greyish-brown. Leaves alternate, chartaceous, about ¼in. apart, broadly elliptic, petioled, 2¼in.–2¾in. long, 1½in.–2in. broad, margin upper three-fourths sinuate-crenate, crenatures few (5–8), distant, lower portion plain, grass-green, glabrous and shining above, pale greyish-green below, with closely appressed hairs (young leaves pale, and very hairy on both sides), tip acute; base truncate and slightly dimidiate, the right side shorter; midrib and veins hairy above, hairs white, appressed, glistening; midrib below stout and with primary veins coloured brown, prominent; the veins few, distant, alternate, curvilinear and intramarginal, and not at right angles; petioles stout, firm, subterete, ½in. long, channelled above, bases slightly decurrent, densely hairy, with closely appressed brown hairs (and so branchlets). Inflorescence subterminal and axillary, semi-erect in thick spreading many-branched corymbs, peduncles slender, subfasciculate, 3–6 together, sub 3in. long, pale-grey, pubescent, each much and dichotomously branched at top into 3–5 subpeduncles, each bearing 2–4 heads; pedicels very slender, 2–3 lines long, each with a small linear-ovate bracteole, appressed at base. Heads very numerous, close, small, oblong, 2½ lines long, 3 lines diameter. Involucral scales few, distant, imbricate in 4 rows, ovate, hairy, the outermost shortest, the innermost longest, their tips truncate and very woolly. Florets—of ray, 8, limb white, 4-nerved, tip trifid, recurved, tube hairy;—of disk, 6–7, limb pale-yellow, 5-cleft, pubescent on outside; stigmas exserted, obtuse, rough; pappus few, erect, scabrid, acute, irregular, red-pink, shorter than florets, that of ray as long as tube. Achene linear, ½ line long, angled, pubescent; hairs minute, white, glistening. Receptacle ridgy, with rather large intervening scales.

Hab. On Ruahine mountain-range, County Waipawa; 1893–94: *Mr. A. Olsen*, who also has the plant flourishing in his garden.

Obs. The alliances of this species are with *O. nitida*, Hook. f., and *O. populifolia*, Col. (Trans. N.Z. Inst., vol. xvii., p. 243), and *O. suborbiculata*, Col. (*l.c.*, vol. xviii., p. 263), but differing from them all in several characters. Its rose-red pappus gives the flowers a peculiar and pleasing appearance. The indumentum—flat, lanceolate, membranous—is of Bentham's Division I.

Genus 3. **Celmisia**, Cass.

1. *C. ruahinensis*, sp. nov.

Rhizome stout, with many long straggling thick rootlets. Leaves 20–25, tufted, sub-narrow-oblong-lanceolate, 2½in. to 3in. long, ¾in. broad, subacute, coriaceous, glabrous green and obsoletely ribbed above (young leaves having a fine filmy-white scurfy indumentum), thickly coated below with sub-appressed light-yellowish-white wool, margins entire and subrevolute, midrib below obsolete, slightly contracted at petiole, which is as long as or longer than leaves, ¾in. wide, increasing towards base, thin, purple, margin glabrous and free from hairs. Flowers 5: scape stout, twice length of leaves, cottony, subappressed; bracts several, distant, 9–12 lines long, finely subulate, thin, green above, cottony below, 3 lines wide at base, clasping, extending to head and there embracing involucre. Head 1½in. diameter, involucral scales numerous, subulate, erect, woolly at margins and tips. Ray-florets, ligula ½in. long, linear-spathulate, white, tips obtuse entire and slightly emarginate, tube glabrous, not thickened below; disk-florets, dark-yellow, glossy, 5-cleft; styles long, exserted from tubes, stigma linear-obtuse slightly and sparsely muricated; pappus few, erect, wavy, irregular, 1–2–3 lines long, scabrid, acute. Achene linear, terete, 2 lines long, quite glabrous.

Hab. Ruahine mountain-range, east side, County of Waipawa: *Mr. A. Olsen.*

Obs. A species near to *C. spectabilis*, Hook. f., from same mountain-range at higher altitude, differing, however, in several characters: in leaves, smaller margins entire, wool beneath semi-appressed and of a lighter colour, midrib not prominent, petioles thin, purple, not hairy; in ray-florets, ligula linear-spathulate, tips entire, tube glabrous and not thickened below; in longer exserted styles (both ray and disk), and in slender narrow-oblong obtuse, not deltoid, stigmas, which are very sparingly muricate.

Genus 7. **Bidens**, Linn.

1. *B. aurantiacus*, sp. nov.

Plant herbaceous erect, glabrous (*prima facie*), tops of stems (two specimens main stems) 10in.–12in. long, simple with a few small axillary branchlets above; stem hard, fibrous, 2½ lines diameter, subangular, deeply striate. Leaves few, distant 4in. apart on stem, trifoliolate, 3in.–4in. long, opposite; central leaflet ovate-acuminate, 2in.–2½in. long, ¾in. broad, the two lateral ones opposite 1in. long and broader in proportion, deeply and closely serrate; teeth large, regular, sharp, subfalcate and minutely serrulate; veins finely reticulate

below; petioles 1in.–1½in. long, semi-amplexicaul, with weak flexuous flattened hairs at bases: petiolules short, slender. Heads terminal, 2–3 together, each single one on a long peduncle 1in.–2in. long, slender striate bare, when two together a long leafy bract at base, hemispherical, 5–6 lines diameter, a leafy linear bracteole at base ¾in. long, base fimbriate. Involucre slightly hairy at base, hairs weak white, bracts in sub 2 rows, the outer ones few, distant, shorter, linear-spathulate very obtuse, dark-green, three dark nerves, margins ciliolate; the inner sub-linear-ovate, acuminate, 3 lines long, tips obtuse and very pubescent, shining, dark-brown with broad yellow margins many-nerved (6–8), nerves dark-red, shorter than florets, with long linear erect yellowish scales between florets, longer than achenes, tips obtuse, 4-nerved; nerves dark-red. Florets sub 40, small, bright dark-orange: ray– few, tip of limb 4-cleft, each lobe with a dark-red central nerve; disk– many, very small infundibuliform, 4-nerved, all much dilated at base. Pappus, three stout erect barbed awns 1½ lines long, bright-yellow, glistering, appearing much above florets, the central awn shorter, sometimes but rarely 4 awns. Achene 2½ lines long, linear subcompressed, flattish, striate, bright-yellow, slightly hairy on upper margins and on striæ, the outer ones shorter and stouter subobovate, with a few distant blunt mucros on their margins. Receptacle (fully ripe) with large alveolar sockets and broad white flattish smooth raised margins.

Hab. Woods at Te Kawakawa, near East Cape; 1894: *Mr. H. Hill.*

Genus 17. **Senecio,** Linn.

1. *S. heterophylla*, sp. nov.

A tall erect branching glabrous perennial herb, 5ft.–6ft. high; root-stems few, very stout, 1in. diameter; much-branched about middle, and still more so at top, branches long slender; branchlets very slender, erect, and sparingly leafed, bearing terminal corymbs. Leaves of two sizes, narrow-lanceolate, acute, thin, roughish, very much and closely veined, dentate-crenate, teeth straight, their tips hardened, sharpish, sub 1 line apart, dark-green above, paler beneath, midrib prominent on underside; the larger leaves few distant scattered on main stems, 5in.–6in. long, ¾in. wide, sessile and largely auricled, auricles much dentate; the smaller leaves numerous, 2in.–3in. long, 2–3 lines wide, almost linear, petiolate, subopposite and close on small branchlets, springing from the axils of the larger leaves; the young half-developed leaves are very hairy, with short fugacious white hairs, but the single scattered smaller leaves on the upper branchlets are sessile and auricled

like the large ones. Heads small, in large loose-spreading corymbs. Peduncles and pedicels very slender, filiform, rather dry, ½in.–1in. long, each having 2–5 scattered bracteoles. Involucre small, narrow-cylindric, 3 lines long, nearly as long as the florets, green, with a few small bracteoles at base; scales 9, narrow subulate, 3-nerved, with white scarious margins, their tips obtuse and slightly coloured, ciliolate. Florets sub 20, tubular, very slender, capillary, slightly campanulate at apex and dilated at base, greyish-green, glabrous, tips 3-fid, lobes laciniate, slightly tinged with yellow; stigmas spreading recurved subcylindrical scaberulous, tips thickened, dark-coloured. Achene linear, $\frac{1}{10}$in. long, slightly grooved, scabrid on angles, ends obtuse, pale-brown, apex with a ring of very minute white hairs. Pappus slender, erect, white, shining, scabrid, tips acute, longer than florets. Receptacle raised, pustulate, slightly ridgy with minute toothed scales.

Hab. In deep forests near Dannevirke, County of Waipawa; March, 1894; also near Woodville, 1890: *W. C.*

Obs. This fine and striking herb differs considerably from all our endemic species of this genus. I had met with one small plant of it, about 1ft. high, late in the autumn of 1890, near Woodville, which was long past flowering, and only retained 2–3 dry and withered involucres without fruit; and not having seen it since, though diligently sought, had all but given it up, when, most unexpectedly, three years after I came on some very fine specimens in the forest. Unfortunately their larger leaves were all but quite devoured by small larvæ (apparently of some moth) that were feeding on them in great numbers.

2. *S. distinctus*, sp. nov.

Shrub 5ft.–6ft. high; branchlets (specimens) slender, erect, simple, 8in.–10in. long, 1 line diameter, much-ribbed-striate, leafy at tops, bare below. Leaves rather close, opposite, petiolate, 1½in.–2in. long, 9–10 lines wide, narrow-oblong-obtuse, slightly tapering, deeply crenate-dentate, the toothed portion peculiar in shape, and in appearance reminding one—*prima facie*—of the merlons of a battlement, each being 1–2–3-toothed, teeth hard and pointed, and often with a small tooth in the crenate hollow, glabrous and finely veined above, but closely covered below with whitish-grey scurf that becomes brown in age; venules very numerous, compoundly anastomosing; midrib prominent below; petioles slender, 5–10 lines long, striate, channelled above, slightly pubescent-scurfy. Flowers terminal in small rather loose leafy corymbs; the extreme peduncles very slender (almost capillary), ½in.–¾in. long, each bearing a single

head with two long linear bracteoles at base; floral leaves rather numerous, one generally at base of each pedicel, subobovate, ¼in.–¾in. long, on long and very slender petioles. Heads small, obconical, sub ½in. long, few-flowered. Involucral bracts 5 (sub 2 rows), thickish, slightly scurfy, linear-ovate, the 2 outer with tips acute, the 3 inner broader, margins membranous, tips ciliolate. Florets few: ray– 3, limb yellow, 10-nerved, 4-notched at tips; disk– 4, pale, limb 6-lobed. Anthers and styles largely exserted; style curved, diverging, thick; stigmas truncate roughish. Pappus few, white, slender, scabrid, tips pointed bifid, shorter than floret. Achene glabrous, slightly striate, dark-brown, sublinear, thickened at top.

Hab. Woods between Poverty Bay and Tolaga Bay; 1894: *Mr. H. Hill.*

Order LIII. Scrophularineæ.

Genus 1. **Calceolaria**, Linn.

1. *C. (Jovellana) albula*, sp. nov.

Plant perennial, bushy, erect, 10in.–12in. high; stems stoutish, striate, much-branched, rough (scabrid) pubescent; hairs substrigosely appressed. Leaves broadly ovate, tip subacute, 1½in.–1¾in. long, 1in.–1¼in. broad, chartaceous, rough subhispid and muricatulate on both sides, dark-green above, very pale green below, with a reddish tinge; margins coarsely bi- or tri-serrate, their base common, and slightly subtruncate; petioles 9–10 lines long. Flowering-stems erect, slender, 6in.–8in. high, yellowish-green tinged with red; flowers in a compound loose panicle, 3in.–4in. long, many-flowered; subpanicles 1½in. long, opposite decussate, diverging, subcorymbose, each with several flowers on slender pedicels 3–4 lines long, 1½in. apart on main rhachis, the lowest pair with two leafy lanceolate bracts ¾in. long at base; flowers erect, drooping, fugacious; calyx rather large, clasping (spreading in fruit), reddish-brown, rough-pubescent subhispid without, glabrous green and 3-veined within; segments 4, broadly deltoid, obtuse and subacute, not cut to base. Corolla suborbicular, 4 lines diameter, densely pubescent, white without, minutely purple-spotted within lower half; tube 0; lips concave entire nearly equal, the upper a little smaller, the lower scarcely incurved, margins thickened and largely pubescent, almost hairy; base of corolla within hairy, the hairs dense, long, wavy. Stamens short, stout, white; anthers orbicular; style erect, long, exserted; stigma small, capitate, penicillate. Ovary ovoid, glabrous, shining, tuberculate, tip obtuse.

Hab. Margins of woods, hilly country between Napier and Taupo Lake; 1893–94: *Mr. W. F. C. Sturm.*

Obs. I. A species very near to *C. sinclairii*, Hook., differing, however, from it mainly in the smaller size and entire lips of corolla, which is white without, with minute pale-purple spots within below, and the hairs at the base of corolla within long and wavy, the stigma rough, and the ovary more obtuse, shining, and tuberculate.

II. Sir W. J. Hooker, in describing *C. sinclairii*, observes that "the corolla has both its lips concave and so far expanded as to approach that of *Jovellana*"; and that "it may, indeed, be considered a connecting-link between the two genera." ("Icones Plantarum," tab. DLXI.) Yet the inferior lip of *C. sinclairii* is 3-lobed. Had Sir William seen this plant, with nearly equal and entire lips not incurved, he would certainly have placed it under *Jovellana*.

2. *C.* (*Jovellana*) *sturmii*, sp. nov.

Plant erect, simple, very slender, 12in.–16in. high, few-leaved; stems reddish-brown compressed striate, slightly pubescent. Leaves distant, opposite in pairs (3–4 pairs on stem), 2in.–3in. apart, broadly elliptic, 2in.–2½in. long, 1¼in.–1½in. broad, very thin, spreading, slightly scabrous above, almost glabrous below, a few small hairs on veins; margins bi-serrate, teeth apiculate; tip subacute, base truncate; petioles very slender straight patent, 2in. long., $\frac{1}{25}$in. wide. Flowers few, in a small loose terminal panicle, 1in.–2in. long, the lowermost pair of subpanicles opposite on rhachis 1in.–1½in. long; pedicels filiform, 2–3 lines long. Calyx green, slightly scabrid-pubescent, segments 4, deltoid, tips subacute. Corolla very small, thin, globular, $\frac{1}{10}$in. diameter, white with large purple spots within, lips nearly equal, their margins thin and slightly puberulent, the upper lip emarginate; base of corolla within glabrous; stamens short, stout; anthers cordate, large, white; style and stigma simple. Ovary shining, pitted minutely.

Hab. On the west side of the Kaweka mountain-range, near Napier; 1893–94: *Mr. W. F. C. Sturm.*

Obs. I. This species, like the preceding, is near to *C. sinclairii*, but differs more largely in general appearance and in size; its peculiar membranous leaves patent on long narrow (almost filiform) petioles, and very small flowers, with much less pubescence and thin margins, and anthers cordate, and glabrous throat of corolla, which is also dark-purple spotted within, the spots larger and showing through the thin corolla.

II. I have seen and examined several specimens of this and of the other plant (*supra*), and find them to be remarkably regular throughout in their characters. I have also given a

large amount of time in close and repeated examinations of them, thinking, at first, they were merely varieties of *C. sinclairii*, and have concluded in their being distinct.

Genus 7. **Veronica**, Linn.

1. *V. venustula*, sp. nov.

A small compact bushy low shrub, 6in.–9in. high; branches and branchlets many, short. Leaves numerous, subdecussate and subimbricate, close, sub-obovate-oblong, 7–8 lines long, 4 lines broad, acute, patent, thickish, dark-green, glabrous, midrib rather prominent below at tip; petioles very short, stout, flattish. Flowers rather large for shrub, terminal, crowded in subcorymbs on short racemes 1in.–1¼in. long; pedicels 2½ lines long, puberulent; bracts subulate, acute, as long as pedicels, margins (as also sepals) ciliolate, the hairs glandular. Sepals sub-linear-ovate, as long as ovary. Corolla pure white (buds purple-tinted on outside before expanding), segments 4, 3 of them sub-ovate-acute, 1 smaller and narrower; tube as long as limb, throat pubescent; stamens erect exserted, longer than corolla; anthers purple, sagittate, tips obtuse, subversatile; style longer than stamens; stigma capitate. Capsule broadly-obovoid obtuse turgid, glabrous, dark-brown, 2½ lines long, twice length of calyx—which also increases in size in fruiting. Seeds few, broadly-elliptic, 1 line long, thin, smooth, sub-plano-convex, light-brown, notched at one end.

Hab. On eastern side of Ruahine mountain-range, County of Waipawa; 1892–94: *Mr. A. Olsen.*

Obs. A neat-looking shrub of very compact growth, allied to *V. lævis*, and to *V. buxifolia*, but differing from them in several characters,—as, leaves not keeled nor cordate, pedicels long, sepals and bracts long narrow acute and glandular, flowers terminal forming thick heads, corolla tube long, and throat hairy.

Order LXXIII. Piperaceæ.

Genus 1. **Peperomia**, Ruiz and Pavon.

1. *P. muricatulata*, sp. nov.

Plant herbaceous, succulent, glabrous, glossy, ascending and erect, simple, 10in.–12in. high; stems stout, as thick as a goose-quill, green; rootlets produced from lower nodes where stem decumbent. Leaves few, alternate distant (¾in. apart on stem), orbicular and orbicular-obovate, 1in.–1½in. long, slightly tapering at base, 3- (the largest 5-) nerved, nerves apparent, anastomosing at tip and margins, dark-green above pale-green below, petiolate; petioles 3 lines long, semiterete, deeply channelled above, lateral edges at base decurrent.

Spike (damaged) axillary, narrow, ½in. long; berry small, globular, muricatulate, dark-brown when ripe.

Hab. Woods near the East Cape; 1894: *Mr. H. Hill.*

Obs. A far more robust and different-looking species than the commoner N. one, *P. urvilleana*. I received several specimens, but, owing to their succulent nature, and long and close confinement in carriage hither, they were all but useless.

2. *P. novæ-zealandiæ*, sp. nov.

Plant small, herbaceous, succulent, glabrous, cæspitose-bushy, erect, 12–14 branches from one rootstock; rootstock thick, irregular, knotty; rootlets numerous, terete, 1–1½ lines diameter, hairy. Branches dichotomous, 4in.–9in. high, spreading, leafy above, bare below, striate; upper branches puberulent; hairs patent. Leaves opposite whorled, 4 and 3 in a whorl, broadly elliptic and suborbicular, 4–5 (rarely 6) lines long, 4–5 lines broad, rounded at both ends, numerous above (not crowded), thickish, slightly concave, dark-green above, paler below, minutely and irregularly punctiform, young leaves puberulent below with short white patent and distant hairs; veins obsolete fresh, but tri-nerved with many veinlets dry; petioles stoutish, subterete, 1–1½ lines long, slightly pubescent, as also peduncles. Spikes terminal single erect, slender, ¼in.–¾in. long, pale-green; peduncle slender, shorter than spike, 4–6 lines long; bracts (or squamæ) under fruit, circular peltate, margins finely ciliolate; anthers very small, pale, orbicular with a deep crease, intermixed throughout spike, filaments very short. Berry ovoid, $\frac{1}{20}$in. long, tip produced obtuse, reddish when ripe.

Hab. Woods near the East Cape; 1894: *Mr. H. Hill.*

Obs. A peculiarly neat little plant, very different from all other species of this large genus known to me; unfortunately, it does not dry well, though better than the preceding species, from which the large fleshy leaves all fall away in drying.

Order LXXIV. Balanophoreæ.

Genus 1. **Dactylanthus**, Hook. f.

1. *D. taylori*, Hook. f.

[For description, see "Handbook of the New Zealand Flora," p. 255. I mention this highly curious, peculiar, and very scarce plant (it having only been met with *twice* during the last fifty years since its first detection by the Rev. R. Taylor—once by Mr. A. Hamilton, near Tarawera, Hawke's Bay, and now by Mr. H. Hill), though not quite new, to give its new *habitat*—woods near the East Cape, whence Mr. Hill brought some very fine specimens, unfortunately, however, like the preceding, much damaged in long transit.]

Order LXXV. Coniferæ.

Genus 3. **Podocarpus,** L'Héritier.

1. *P. montana*, sp. nov.

Plant a low rambling shrub of diffuse growth. Leaves numerous close subimbricate on all branchlets, subsexfariously disposed, oblong-lanceolate, 3 lines long, apiculate, thickish, slightly falcate, spreading and recurved, yellowish-green, glabrous; midrib prominent on both sides and with the margins thickened, striate longitudinally (*sub* lens) in minute stippled white (glaucous) striæ; petiole 1 line long, much decurrent, raised from one leaf to another, giving the branchlet a ridgy appearance. *Male:* Catkins axillary, erect on a slender peduncle 3 lines long, having a thin brown oblong scarious bracteole 2 lines long at its base in front, its tip jagged; usually 3 (sometimes 2) spikes together, the central one longest, very slender as long as peduncle, sessile, red; 2 lateral bracts sub 2 lines long at their base, patent, green, oblong, subapiculate, thickish; the peduncle marked with decurrent sunken lines from them; between, in front, 3 small bracteoles, green, concave, appressed, tips entire and subacute; and, behind, 3 others, smaller, thinner, concave, with their tips jagged; anthers sub-broadly orbiculate, their tips, or connectives, 3-fid or jagged. *Female:* Ovule ovoid, subacute, 2 lines long, sessile on thickened peduncle, bright-red, subglobular or somewhat turbinate, ¼in. long, fleshy, juicy, edible, with 2 small lateral acute points or horns, 1 on each side of ovule (sometimes, but rarely, 3), the lower part of peduncle slender, green, short, axillary.

Hab. High up on Ruahine mountain-range, east side, County of Waipawa; April and December, 1894: *Mr. W. F. Howlett.*

Obs. I. A species near to *P. nivalis*, Hook. f. (also discovered on same range, west side), but differing in its smaller leaves, slenderer amentæ which are also much bracteolate at their bases, and with the tips of their anthers jagged, somewhat resembling those of *P. totara*, but those of *P. totara* are larger, more produced, and more largely jagged. In one of my specimens there are three peduncles of male spikes very nearly forming a whorl near the top of a branchlet, two bearing each 3 and one 2 spikes. This species is also nearly allied to *P. alpina*, Br., a Tasmanian and Victorian species, which mainly differs in its produced connectivum ("*connectivo apice in cornu producto*") and in its spikes being "sessile and solitary," &c.—a plant, too, found there at "from 3,000ft. to 4,000ft. altitude," much the same as these two here in New Zealand.

II. I can quite fancy it becoming an interesting and useful scientific study in "days to come" for some future botanist to take up those three species (*P. alpina*, *P. nivalis*, and *P. montana*), and, being well supplied with fresh specimens of them all in their various states, to enter on a close and exhaustive examination and dissection of them, to ascertain whether they are not varieties of one mountain species.

Class II. MONOCOTYLEDONS.

Order I. Orchideæ.

Genus 11. **Caladenia**, Br.

1. *C. macrophylla*, sp. nov.

Stem stout below, glabrous; slender above with leaves and flowers glandular-hairy, 4in. high. Leaves 2 together within 1 sheath near base, 1½in. from it, the larger and outer leaf ovate acuminate acute, 2in. long, 1in. broad, 6-veined, margins ciliolate with weak white ciliolæ; the inner one much smaller, sublanceolate acuminate; green, brownish-spotted, chartaceous; at top of scape a sheathing bract acuminate half embracing ovary, both also glandular-hairy. Flower single, sub 1in. broad expanded, whitish with a tinge of pink, membranous. Dorsal sepal obovate-oblong, much veined, incurved, tip subacute; lateral sepals 7 lines long, linear oblong acuminate; lateral petals shorter and narrower, linear subacute; labellum oblong-obovate, no claw, veined, tip rounded, 2 rows of small yellowish ridgy calli subconnected, one on each side of the middle line from the middle of labellum to base, increasing in size downwards, column largely incurved, the tip hooded, winged laterally and equally throughout. Ovary long, slender.

Hab. Ruahine mountain-range, east side; 1894: *Mr. A. Olsen.*

Obs. A plant that has caused me much trouble as to fixing its proper genus; it is certainly near *C.* (?) *bifolia*, Hook. f. (*Chiloglottis*, Mueller), and, were it not for its completely-hooded column, from its wings being continued unbroken over it, I should have preferred placing it under *Chiloglottis*, this genus having its "column 2-fid at the tip" (Hook., *l.c.*, p 269).

Order VII. Liliaceæ.

Genus 4. **Dianella**, Lamarck.

1. *D. reflexa*, sp. nov.

Leaves distichous, sheathing at base, 20in.–24in. long, 6–7 lines wide, subcoriaceous, linear acuminate, green on both sides, shining above, margins and keel (prominent) entire, or

very slightly and distantly scaberulous with small dark-brown spots, margins somewhat revolute. Flowering-stems erect, slender, dark-green, terete, smooth, 18in. high, a single thin leafy bract 1½in.–2in. long near base; panicle loose, 10in.–12in. long; subpanicles few, 2½in.–3in. long, branched, spreading, 1½in.–2in. distant on stem, alternate; bract at base 1in. long, sessile, membranous, subulate acuminate, green; branchlets very slender, 3–4 flowers on compound capillary pedicels, each 5–9 lines long, with a minute bracteole at base. Flowers: Buds (*alabastron*) linear, 2 lines long; perianth expanded 4½ lines diameter, segments membranous, glabrous, recurved, unequal; 3 outer narrow-oblong, tips obtuse tufted with short hairs, outside purplish, sides white, margins purple, many (5–6) nerved, nerves black; 3 inner broadly oblong, white, shining, tips emarginate, 3-nerved, nerves greenish. Filaments erect, a little shorter than style, the basal two-fifths white, the upper three-fifths bearded dark-orange thickening upwards close to anther, obovoid; anther pale-yellow, linear, narrower than filament, sessile. Style erect, stoutish; stigma simple, small. Ovary subglobose, glabrous, shining.

Hab. Woods near East Cape; 1893–94: *Mr. H. Hill.*

Obs. I. After a long and extra-careful examination I believe this plant to be distinct from *D. intermedia*, Endl., and also from *D. nigra*, mihi (Trans. N.Z. Inst., vol. xvi., p. 339). Of *D. intermedia* little is given as to specific characters in Hooker's "Flora Novæ Zealandiæ" and in the "Handbook of New Zealand Flora," but fortunately I possess Endlicher's "Floræ Norfolkicæ," in which he gives a very long and elaborate description of *D. intermedia*, originally discovered in Norfolk Island. A few of its prominent characters I here give, to show its difference from this plant: "Folia marginibus carinaque aculeato-serrulatis. Scapus basi tereti compressus, apice angulatus. Ramuli arcuati pedicellique nutantes angulato-tetragoni, quatuor lineas longi. Perigonium sex-partitum æquante, substellato-patens. Foliolia tria exteriora oblonga obtusa, extus virescentia; . . . interiora conformia, medio viridia. Filamentia, . . . apice in massam ovatam flavam. Antheræ viridi-flavescentes." (*Loc. cit.*, p. 28.)

II. I have mentioned *D. nigra*, mihi. This species, I find, is disallowed in "Index Kewensis," stated therein to be= *D. intermedia*, Endl.; but this I cannot agree in, seeing that it does not square with Endlicher's description, as shown by me in my full description of my plant (*l.c.*). One thing, however, is pretty certain: that the species are difficult to determine. Hooker fil., in his "Floræ Tasmaniæ," says of this genus, "About ten Australian and Tasmanian species are known to me. They are very difficult to discriminate. . . . The stamens appear to me to afford the best character" (*l.c.*,

vol. ii., p. 56). I wholly concur in his remark on the stamens. Bentham, in his "Flora Australiensis," enumerates twenty-one species. Of these he gives only five as Australian, disallowing sixteen. Many of them were also described and figured by eminent botanists. He also says, "In their typical forms the five Australian species are very distinct, but they are all so variable, and connected by so many intermediates, that I have found it very difficult to distribute satisfactorily the numerous dried specimens before me. It is not impossible, however, that a careful study of living plants in their native country may disclose more positive characters to distinguish even twice as many more or less permanent forms" (*l.c.*, vol. vii., p. 14). In this remark I fully believe, and have acted upon it in examining and describing my two species, both from living specimens. And, later still, in "Index Kewensis," out of forty described species therein brought forward, only thirteen are allowed to stand. I may further observe that *D. intermedia*, Endl. (or our northern New Zealand plant), was pretty common at the north, among fern (*Pteris esculenta*), in the dry hilly grounds, and on margins of woods; but I have never seen it here. *D. nigra* I have only seen in two localities here south in thirty years; and this plant now described by me, Mr. Hill says he had never seen before.

Order XI. Cyperaceæ.

Genus 14. **Carex**, Linn.

1. *C. smaragdina*, sp. nov.

A low densely cæspitose flaccid glabrous dark-green species of very peculiar aspect. Roots numerous, wiry, short. Culms 10in.–14in. long, $\frac{1}{20}$in. wide, very slender weak flat striate, with 2–3 short leaves near base, spread all around flat on the ground together with the leaves forming a circle. Leaves one-third length of culms, narrow linear acuminate, grass-like, $\frac{1}{10}$in. wide, minutely serrulate at tips (*sub* lens), slightly and distantly so below, generally 3 together with 3 sheaths at and near base, sheaths with netted veins, their tips obtuse and apiculate. Spikelets usually 3, sometimes (but rarely) 5, very close together, forming a small head or cluster, sessile, subquadrangular, stout, $\frac{1}{4}$in.–$\frac{1}{2}$in. long, 2–3 lines wide; bracts 2, unequal, 3in. and 1½in., leaf-like, very narrow, the smaller one filiform, thin; glumes broadly ovate, acuminate, white with dark-green central nerve, tips serrate. Utricle as large as the glume, broadly ovate-lanceolate, plano-convex, green without and at margins below, pale-fawn within, many-nerved, nerves prominent, beak produced, sharply bicuspidate; stigmas 2, long, roughish, much curved, brown. Anther (?) linear, acute, serrulate at tip.

Hab. Interior deep damp forests at Dannevirke, County of Waipawa; March, 1894: *W. C.*

Obs. A highly curious species, differing much from any other of this genus known to me; its bushy decumbent dark-green spreading aspect is most striking. It was plentiful there in two spots; but, though I brought away many specimens, I have not detected any male flowers save *one* old anther at the base of a spikelet; and, on seeking fresh specimens in the following summer season, I found the whole forest had been felled and burnt, thus destroying much valuable timber!

Art. XLVII.—*A Description of Two New Ferns and One New* Lycopodium, *lately detected in our New Zealand Forests.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th November, 1894.*]

Genus 2.* **Hemitelia,** Br.

1. *H. microphylla*, sp. nov.

Trunk erect, 9ft. to 10ft. high, stout, girth nearly equal throughout, at base 20in., near top 21in., with numerous old and dry bleached stipites (without their pinnæ) hanging down from below crown. Fronds, rather few, 15, spreading, horizontal, sub-oblong-lanceolate, broadest above middle, 5½ft.–6ft. long, 2ft. 6in. wide, bipinnate, grass-green above, pale-green below, softish, densely clothed with light-brown scales and hairs; rhachis dark mahogany-brown and glossy below, with a pale continuous raised line above, lateral from pinna to pinna; stipe short, sub 5in., very scaly, scales long. Pinnæ linear-oblong, tip very acuminate, 13in. long, 3¼in. wide near base, 3½in. apart on rhachis, opposite, leafy to base; pinnules regular, close but not imbricate, 1¾in. long, ½in. wide, broadest at base, lower pair of segments pinnate and overlapping rhachis. Segments linear-oblong, entire, sometimes slightly crenulate, sub-serrate-crenate at tip; tip acute submucronate. Sori orbicular, regularly disposed at base of lowest pair of forked veins, 2–4 on a segment. Involucre rather large, concave, three-fourths round sorus, gaping, persistent, closed on costal side, pale, with dark centre, margin

* In "Handbook of the New Zealand Flora" included in *Cyathea*.

even. Receptacle pale, erect, broadly ovoid, pilose. Veins few, usually 5 pairs, the lower 2–3 pairs forked, single above, alternate, clear, white, not extending to margin. Scales very numerous and of different sizes, narrow, subulate; of stipe 1in., of frond 2–3 lines long, brown, with many dark (black) veins, the central ones parallel from base to apex, forming long vertical loops, the lateral ones anastomosing freely, the sides of scales subtranslucent, margins entire above, irregularly and slightly sharp-serrate below, their bases dilated and finely laciniate (a truly remarkable sight under a microscope).

Hab. In dense forests north-west from Dannevirke, County of Waipawa; 1894: *W. C.*

Obs. I. A species near *H. smithii*, Hook. f., but differing in several characters; as, acuminate pinnæ, smaller entire segments, colour, pilose receptacles, and very peculiar and largely-veined scales of a different colour, &c. Its general appearance is also very different, especially young plants with trunks 4ft. to 5ft. high (before they bear sori): these have a very striking appearance; their pleasing vivid grass-green colour, small segments, and densely scaly fronds arrest the beholder's eye and attention.

II. I have long been of opinion that greater scrutiny should be given by pteridologists (not mere amateurs, fern-growers, and collectors) to the *scales* of ferns—their form, consistency, venation, colour, and structure. Nature is ever great, true, and constant in what men term *small* things.

Genus 11. **Adiantum**, Linn.

1. *A. viridescens*, sp. nov.

Plant small, indistinctly sub-pedate-deltoid, acuminate; stipe 4in.–5in., dry, channelled on upper surface, bright red-brown; frond 5in.–6in. long, bipinnate, pinnæ 2, sometimes 3, pairs, tripinnate at base of 2 lower pinnæ; pinnules stipitate, free, rather distant, glabrous, shining, grass-green on both sides, thin, flat; main segments narrow, sublinear, oblong, 7–8 lines long, 2 lines wide, falcate, lower margin entire, upper margin sublaciniate; barren laciniæ serrate, teeth white produced sharp; fertile very broad, rounded, incurved over involucre, with orbicular space between, margins white; terminal pinnules very long, narrow ovate-acuminate; stipes, rhachises, and petioles scaly and hairy; scales and hair bright red-brown, very long and curly; basal scales dense, flat, subulate, 1in.–1½in. long, veins netted. Involucres few (4–6) on upper margin, large orbicular, flat, with a very deep sinus corresponding with laciniæ; white, membranaceous (hyaline young), with dark centre,—gaping, brown, crisped and curled in age. Veins numerous, branching, having in larger segments

and in terminal pinnule a middle vein which is pinnate and forked, 2 pairs (4) to each involucre.

Hab.—Wooded district, Kumeroa, near the River Manawatu.

Obs. A neat species allied to *A. fulvum*, Raoul, but differing from that species in its smaller size, bright-green thin glabrous shining narrow finely cut and more stipitate pinnules, large orbicular hyaline and flat involucres, largely-branched compound venation, and its very hairy and scaly bright red-brown stipe and rhachises.

Order II. LYCOPODIACEÆ.

Genus 2. **Lycopodium**, Linn.

1. *L. polycephalum*, sp. nov.

Plant (dried specimens) erect, stout, 9in.–10in. high, main stem woody, as thick as a goose-quill, much and dichotomously branched throughout; branches erect, their tips (heads of spikes) drooping recurved. Leaves very numerous, mostly vertical adpressed, sometimes patent, $\frac{1}{10}$in. long, subulate, semiterete, acute, entire not keeled, smooth, shining, wavy, inserted about six rows on all the stems and branches, close, imbricate. Spikes terminal on all branches, 1–2–3 together, subcylindrical, oblong-ovate, obtuse, sessile, sub $\frac{1}{2}$in. long, pale yellowish-fawn colour; scales in about 8 rows, very close and largely imbricate, $\frac{1}{10}$in. long, ovate-acuminate, rough on outside, margins serrate, tip produced long entire acute; capsules suborbicular, white, shining narrower than scale.

Hab. High land near East Cape; 1894: *Mr. H. Hill.*

Obs. A species allied to *L. densum* and to *L. cernuum*, particularly the latter, but differing from that species in several characters—in smaller leaves that are vertical shining and not keeled, spikes several together and not incurved, points of scales not serrate, &c.

Art. XLVIII.—*An Account of the Finding of Two Australian Plants, hitherto unnoticed, here in New Zealand.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th November, 1894.*]

1. *Erythræa australis*, Br.

An erect glabrous annual, from under 6in. to 1½ft. high, the branches few and not very spreading. Leaves sessile, ovate-oblong elliptical or lanceolate, mostly obtuse; the lower

ones stem-clasping, nearly 1in. long. Flowers nearly sessile along the more or less elongated branches of the once-forked or dichotomous cyme, with a leafy bract under each flower, thus forming one-sided interrupted leafy spikes. Calyx narrow, 3–4 lines long, with 4 (rarely 5) angles and acute teeth or lobes. Corolla-tube usually exceeding the calyx, but sometimes shorter; lobes ovate or oblong, much shorter than the tube. Capsule oblong, shorter than the calyx. Seeds small, reticulated-striate.

Hab. Woods, highlands near East Cape; 1893: *Mr. H. Hill.*

Obs. This species, the only one in Australia, where it is generally found in all the colonies, and also in Tasmania, is also in New Caledonia and the Loochoo Islands, and is said to differ only from *E. spicata* (a species common in the Mediterranean region, and eastward at least as far as Afghanistan) in the flowers, usually but not commonly 4-merous.

2. *Alisma plantago*, Linn.

Rootstock perennial, sometimes very hard, and almost bulbous, with the thickened sheathing bases of the petioles. Leaves ovate-oblong or elliptical, shortly acuminate, 3in. to 4in. long in well-grown specimens, usually 7-nerved, the transverse veinlets very oblique, not close, and more or less contracted by reticulations. Flowering-stem 1ft. to 4ft high, with a large loose panicle, often above 1ft. long, with whorled divaricate branches and pedicels. Outer perianth-segments ovate striate persistent, above 1 line long; inner ones twice as large, of a pale-pink, very fugacious. Carpels 15 to 20, obovate, laterally flattened, 1 to $1\frac{1}{4}$ lines long, bearing the remains of the style on the inner edge below the apex, and marked on the back with an impressed or slightly prominent dorsal nerve, the whole forming a flat ring of $2\frac{1}{2}$ to 6 lines diameter with a depressed centre.

Hab. In watercourses on the banks of the River Tukituki, east of Napier, Hawke's Bay; 1892 and 1893: *Mr. H. Hill.*

Obs. This species is found in New South Wales and in Victoria, and is also frequent in many parts of Britain by lakes, streams, and ditches. Mr. Hill first met with it in 1892, but long past flowering, and much decayed in its package when it reached me, so I was obliged to wait another year, when, again through the kindness of Mr. Hill, I obtained better specimens.

As there is no difference that I am aware of between those two plants found in New Zealand by Mr. Hill and the Australian ones, I have used Bentham's able descriptions of them, copied from his "Flora Australiensis."

Art. XLIX.—*On New Zealand Mosses.*

By T. W. Naylor Beckett, F.L.S.

[*Read before the Philosophical Institute of Canterbury, 5th September, 1894.*]

Plate XXVIII.

Blindia tenuifolia, H. f. and W., in Hook. Lond. Journ. Bot., iii., p. 542 (*Dicranum*). Plate XXVIII.

"Caulis breviusculus. Folia secunda, falcata, inferne anguste elliptica, sensim longe tenuiterque capillari-subulata, marginibus incurvis, nervo supra basin a lamina indistincto, cellulis elongatis angustis, alaribus pluribus pallide fuscis in folii basi adscendentibus; perichætialia basi brevi suborbiculata, convoluta, nervo longe excurrente. Theca in pedunculo brevi crassiusculo, erecta, breviter ovalis, turbinata, operculo subulato, peristomii dentibus brevibus infra os insidentibus. *Hab.* Fuegia, Hermite Island.—Hooker.

"Caulis uncialis. Folia fusca, inferiora nigrescentia. Pedunculus 3-linearis. Cellulæ alares haud incrassatæ sed laxæ, ab aliis basilaribus vix distinctæ."—Mitten, "Musci Austro-Americani," p. 56.

Dicranum tenuifolium, H. f. and W., Fl. Tasm., ii., p. 180, t. clii., f. 7.

Hab. In a shallow tarn on the top of Mount Thompson, Stewart Island; No. 401: *R. Brown.*

I am indebted to Mr. Robert Brown, of Christchurch, for specimens of this rare moss, which he gathered in April, 1892, on Mount Thompson, the only known habitat in New Zealand. It was originally found by Hooker in Hermite Island, and was in 1888 found in Tasmania by Mr. W. A. Weymouth, in swampy ground at the top of Mount Wellington. I am indebted to him for copious specimens named by Dr. V. F. Brotherus, which have enabled me with certainty to identify the Mount Thompson plant. The plate in Fl. Tasm. does not give a figure of the well-marked suborbiculate perichætial leaves suddenly narrowed into a long subulate apex.

Hedwigia microcyathea, C. Müll., in Bot. Zeit., 1851.

"Very like *H. ciliata*, but the leaves have angular, elliptical, rather firm cells, scarcely or not at all crenulate at their walls, those in the middle longer, papillose, and without chlorophyll, therefore not obscure. Capsule minute, hemispherical, cup-shaped, with large mouth and very thick plicate neck."

No. 347. On boulders, Birdling's Flat, Banks Peninsula. Identified by Dr. Karl Müller. Not uncommon in the South

Island on dry exposed rocks. Penrose, near Auckland; *T. F. Cheeseman*; No. 139. Mr. Kirk informs me that it has only been found at Penrose in the North Island, and there confined to a space not exceeding a few square yards.

Mr. Mitten, in his "Australian Mosses," gives *H. microcyathea*, C.M., as a synonym of *H. ciliata*, but Dr. Hampe (Suppl. Frag. Phyt. Austr., xi., p. 49) and Dr. V. F. Brotherus consider it a good species.

Funaria sphærocarpa, C. Müll.

"*F. hygrometrica* simillima, folia anguste oblongo-lanceolata, semper complicate crispata, nervo valido excurrente percursa, ubique e cellulis elongatis laxis, ad marginem angustioribus reticulata, integerrima, perigonialia integra; theca majuscula siccitate et madore globosa, collo carens, leviter sulcata. *Patria:* Australasia, ad rupes maritimas, Green Cape, Twofold Bay; Mossman; No. 834."—C. Müller, in "Botanische Zeitung," 1851, p. 546.

Hab. This moss is common throughout New Zealand and the islands—Stewart Island, *W. Bell;* Chatham Islands, *T. Kirk;* Great Barrier Island, *Hutton.* I have also specimens of it from Victoria, Queensland, and Tasmania.

The important character distinguishing this moss from the cosmopolitan *F. hygrometrica* is its entire perigonial leaves. In *F. hygrometrica* they are serrated at the apex (Schimp., Syn., p. 384; Braith, Brit. M. Fl., ii., p. 136). There are doubts as to the validity of this species, and neither Mr. Mitten nor Mr. Boswell recognizes its claim to specific rank. Dr. Hampe, however, upheld Dr. Müller in considering it distinct from *Funaria hygrometrica*.

Neckera (Rhystophyllum) hymenodonta, C. Müll.

"Habitus, folia et folii reticulatio *N. pennatæ*, folia caulina magis eroso-denticulata; perist. d. ext. angustiuscule lanceolato-subulati, flavidi, opaci, superne rugulosi, int. in membrana altiuscula tenerrima albida positi, inferne moniliformi-articulati, superne capillares, persistentes punctulati subcarinati. *Patria:* Van Diemen's Land, ad truncos arborum frutiscenti densi infra Bek River, prope Launceston; coll. S. Mossman; No. 746."—Karl Müller, in "Botanische Zeitung," 1851, p. 564.

Neckera pennata, var. *Tasmanica*, Hampe, in "Linnæa," 1852.

Neckera pennata, Wils., in Hooker's Fl. Tasm., ii., p. 204.

Hab. Common in damp bush, growing on rocks and trees, from Stewart Island (*W. Bell*) to Auckland. No. 355 (*T. W. N. B.*), Akaroa, named by Dr. Müller.

Mr. Mitten ("Australian Mosses," p. 35) and Dr. Brotherus consider this a good species, and distinct from the

European moss; and Dr. Hampe, in his latest publication (in F. v. Mueller's Frag. Phyt. Austr., 1880, xi., p. 49), also dopts this view.

EXPLANATION OF PLATE XXVIII.

Blindia tenuifolia, H. f. and W.

From Mount Thompson plant:
2. Leaf, × 32.
3. Comal leaf seen sideways, × 32.
4. Alar cells, × 270.
5. Cells of leaf, × 270.

From Tasmanian plant:
6. Perichætial leaf, × 32.
7. Capsule, × 32.
8. Capsule old and dry, × 32.

ART. L.—*Descriptions of New Native Plants.*

By D. PETRIE, M.A., F.L.S.

[*Read before the Otago Institute, 9th October, 1894.*]

1. Carex hectori, sp. nov.

A densely-tufted grassy species, about 3in. high. Leaves green, erect and rigid, $\frac{1}{20}$in. broad, striate, concave above, convex below, not keeled, strongly serrate, with rather obtuse tips.

Culms shorter than the leaves; spikelets 3 or 4, crowded, sessile, uppermost male only, the rest female; bracts long and leafy.

Glumes broadly lanceolate, acuminate, not bifid, brown with pale (nearly white) midribs, almost as long as the utricles.

Utricles subtriquetrous, fusiform, $\frac{1}{8}$in. long, dark-brown, many-nerved, two prominent opposite greenish wing-like nerves being confluent with the slender bifid serrate beak.

Style long, three-branched.

Hab. Old Man Range (4,800ft.).

This species is somewhat closely allied to *C. uncifolia*, Cheeseman, and less closely to *C. decurtata* of the same author. From *C. uncifolia* it differs in its shorter grassy rather rigid leaves, its tufted habit, and in the shape of the utricles, which are much longer, taper above and below, and end in a much longer slender serrate bifid beak. The style of *C. uncifolia* is very short, and the undivided part hardly projects beyond the utricle. In the present plant the style is as long as the utricle, and the undivided part equals

the style-branches in length. I suspect that my plant from Clark's Diggings, referred to *C. decurtata* in Mr. Cheeseman's last paper (Trans. N.Z. Inst., vol. xxiv., p. 414), is a young state of the present species.

2. **Coprosma ramulosa**, sp. nov.

I propose this name for my *Coprosma pubens*, described in a paper communicated to the Otago Institute last year (see Trans. N.Z. Inst., vol. xxvi., pp. 267 and 268). I now find that the latter name is preoccupied, having been chosen by the late Asa Gray to distinguish a species native to the Sandwich Islands. The flowers of this plant are still unknown.

3. **Danthonia oreophila**, sp. nov.

I propose this name for my *Danthonia pallida*, described in the same paper as the foregoing. In selecting the very appropriate specific name *D. pallida* I overlooked the fact that Robert Brown had applied the same name to an Australian species.

4. **Asprella lævis**, sp. nov.

Culms slender, branched at the base, sparingly leafy, 10in. to 30in. high.

Leaves much shorter than the culms, narrow, flat or involute, thin, smooth, and usually glabrous, but the lower sheaths of the larger forms are downy.

Spike inclined or pendent, narrow-linear, 2½in.–5in. long, of 14 to 26 spikelets.

Spikelets solitary, slender, one- or two-flowered, about $\frac{5}{16}$in. long inclusive of the short blunt mucro.

Empty glumes represented by two very narrow, erect, concave, finely ciliated bristles, three-fourths the length of the flowering-glume. Flowering-glume lanceolate, rounded at the back, smooth, 3- to 5-nerved, shortly and often unequally three-toothed at the apex, the middle tooth forming a short blunt serrate mucro. Palea about four-fifths the length of the flowering-glume, its nerves smooth or delicately ciliate towards the top.

Hab. Catlin's River district, near the seaside; and Matukituki Valley (Lower Wanaka), 1,100ft.

The present species differs from *A. gracilis*, Hook. f., in the smooth obscurely nerved keelless flowering-glumes, which are truncately 3-toothed; and end in a short blunt serrate mucro; and in the constant presence and length of the two filiform ciliate outer glumes. The Catlin's River plant is a very short slender form, everywhere perfectly glabrous, and, except in the flowers, differs rather widely from the specimens from Lake Wanaka.

Art. LI.—*On the Presence of some Noxious Weeds in Nelson District.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 12th March, 1894.*]

Arctium minor, the lesser English burdock.

This plant, to which attention has been called as being dangerous to stock eating it, is growing in several places. I have found it on the Fringe Hill, on the Dun Mountain track, on the Port Hills, in the Maitai Valley, and lately I noticed it growing luxuriantly at Ferntown, near the foot of the Colliery incline, and apparently spreading.

Carduus arvensis, English corn-thistle (the so-called Californian thistle of settlers).

This is growing in fair abundance on the Port Road, and also in Hastings Street, Nelson. The spreading of this plant would be a very serious calamity to the farmers of the district, for, being a perennial, and possessing a creeping rhizome, it is difficult to eradicate. In cornfields in England it sometimes, where it is plentiful, almost completely chokes the corn.

Melilotus arvensis.

A noxious weed—one that spreads rapidly, seeds abundantly, and that cattle will not eat. This is also growing on the Port Road.

Art. LII.—*Botanical Notes: Plants new to Nelson District, &c., from West Wanganui.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 12th March, 1894.*]

On a recent trip to West Wanganui Inlet, *viâ* Collingwood and Pakawau, during the month of February, in company with Messrs. W. H. Bryant and T. M. Melhuish, I made a small collection of plants, &c. These on my return I submitted to T. Kirk, Esq., F.L.S., of Wellington, who states there are several among the specimens of great interest, two being new to the flora of this district; and others, whilst being recorded, have not been collected for a good many years. Mr. Kirk

suggests that further visits should be paid to this district for the special object of collecting specimens of the flora, as it does not appear that any one has yet done so with that definite object in view.

We found the month of February too late in the year, since most of the plants flower much earlier, and it is impossible to be certain as to some species without studying the inflorescence.

The following are the most interesting specimens we collected:—

Eryngium vesiculosum. (New Zealand Handbook says East Coast.)

Mr. Kirk says, "This is a noteworthy addition to the list of Nelson plants, and a marked extension of its range westward." It is growing abundantly on the sea-coast near the inlet.

Veronica elliptica. (Handbook: Canterbury and Otago.)

This has not hitherto been recorded from this province, and is, Mr. Kirk states, a "quite unexpected discovery to be found growing so far north." I found it growing on the rocks on the sea-shore to the north of the inlet. One plant was in flower, the colour being a very handsome light-blue. The Handbook gives the colour as white, but blue is, I believe, also found. It is altogether a handsome shrub, and worthy of cultivation.

Plantago . . . (?)

I noticed only one specimen, a curious form of *Plantago.* The inflorescence was imperfect, and, through rain, was in bad condition when I reached Nelson; consequently Mr. Kirk was unable to identify it. He says it may possibly be *Plantago brownii,* but from its position it may eventually be found to be quite new. Doubtless a more extended search would reveal many more and better specimens.

Pimelea longifolia.

Specimens of this shrub were collected many years ago by Mr. Travers in Nelson District, but since then there is no record of its having been observed. It is growing on the eastern side of the inlet, and is a handsome shrub, partaking somewhat of the appearance of *Pimelea gnidia.*

Phyllocladus trichomanoides.

This species of the so-called celery-leaved pine is reported in vol. xiv. of the Transactions as growing in the Maitai Valley, Nelson. The present specimen is a remarkable westward extension of the species. A good-sized tree was growing on Mr. Harvey's land.

Dicksonia lanata.

This interesting fern is mentioned in the Handbook as growing in Massacre Bay, but it has not been reported as collected since Mr. Travers found it. Mr. Bryant drew my attention to it near Coal Creek, Pakawau, and he tells me he found it near the coal-mines on the West Coast some years ago.

In addition to the foregoing, there were many others more or less rare or interesting: *Pimelea avenaria* in abundance on the sandhills; *Mentha cunninghamii*, with its powerful mint-like odour; a good number of species of *Coprosma*, including *grandifolia* and *baueriana*. Of ferns we found *Lomaria banksii*, *Lomaria nigra*, and the beautiful *Lomaria fraseri* in fair abundance; *Trichomanes elongatum*, *colensoi*, and *strictum* abundant; *Asplenium umbrosum*, the finest specimens I have yet seen, we found near Ferntown, the pinnæ at the base of the frond extending to a width of 2ft. or more. *Lycopodium laterale* and *Schizæa fistulosa* were also plentiful. I hope to be fortunate enough to make another visit at some future time, since the fauna and geology, as well as scenery, are most interesting.

Art. LIII.—*Notes on New Zealand Mosses: Genus* Grimmia.

By Robert Brown.

[*Read before the Philosophical Institute of Canterbury, 6th June, 1894.*]

Plates XXIX.–XXXIV.

Section A.

Columella adhering to the operculum.

1. **Grimmia (Schistidium) aquatica**, sp. nov.

Plants light-green at the tips of the branches, dark below; growing in loose patches from 2in. to 5in. long, subdichotomously branched by innovations. *Stem* and *branches* slender. *Leaves* erecto-patent, loosely imbricating; lower broadly lanceolate, obtuse, very concave, slightly cucullate at the apex; upper ones larger. *Margins* entire, nerved to the apex. *Perichætial leaves* longer than the upper ones, broadly lanceolate-obtuse, cucullate at the apex, concave, margins entire, nerve continuous. *Areola* punctiform, crisped when dry. *Fruitstalk* $\frac{1}{3}\frac{1}{2}$in. *Capsule* sometimes sessile, immersed in the perichætial leaves, subrotund, large, as broad as long, mouth wide. *Peristome* single, 16, entire or slightly

bifid, perforated, red. *Operculum* large, convexo-rostrate, oblique. *Columella* adhering to the operculum. *Calyptra* not found.

Hab. On rocks, submerged in the water of a small tarn, near the summit of Kelly's Hill; altitude, 3,800ft.; growing with *Andrea aquatilis;* November, 1889. Collected by R. B.

2. **Grimmia (Schistidium) searellii,** sp. nov.

Plants yellowish at the tips of the branches, dark-green below, $\frac{3}{4}$in. high, growing in small tufts branched by innovations, fastigiate. *Branches* slender. *Leaves* closely imbricating, diaphanous, erecto-patent; lower leaves ovate-lanceolate, tapering into a hyaline hair-point one-third the length of the leaf, concave. *Margins* entire, keeled. *Nerve* ending at the hyaline hair-point. *Areola:* Upper punctiform, lower quadrate, when dry erect and adpressed. *Perichætial leaves* slightly smaller than the upper ones, but otherwise very similar. *Fruitstalk* extremely short. *Capsule* small, immersed, subrotund, mouth wide. *Peristome* single, 16, perforated, very slightly bifid or entire at the apex. *Operculum* large, mammillate. *Columella* falling away, adherent to the operculum. *Calyptra* not found.

Hab. On rocks, Mount Self, near the River Hurunui; March, 1893. Collected by R. B.

Section B.

Columella not adhering to the operculum.

3. **Grimmia (Schistidium) revisa,** sp. nov.

Plants small, dark-green, growing in tufts $\frac{1}{4}$in.–$\frac{3}{4}$in. high, branched by innovations, fastigiate. *Leaves* erecto-patent, diaphanous, upper and middle lanceolate or oblong-lanceolate, ending in a hyaline toothed hair-point, concave. *Margins* entire, flat or slightly recurved. *Nerve* ending at the hyaline point. *Leaves*, lower ovate-lanceolate or cordate-lanceolate, acute, with or without a hair-point, nerved. *Margins* entire. *Areola:* Upper punctiform, lower oblong-quadrate; when dry erect and closely adpressed. *Perichætial leaves* large, erect, broadly oblong-lanceolate, ending in toothed hyaline hair-point, concave. *Margins* entire. *Fruitstalk* $\frac{1}{3\frac{1}{2}}$in. long. *Capsule* immersed, oblong-ovate, symmetrical. *Operculum* straight, conico-rostrate, about one-third the length of the capsule. *Columella* not falling away, not attached to the operculum. *Peristome* single, 16, irregular, shortly bifid, perforated. *Calyptra* small, mitriform, lobed at the base.

Hab. Damp rocks, Port Lyttelton hills; 1876. Collected by R. B.

This moss is extremely common in the Middle Island.

4. **Grimmia (Schistidium) saxitilis**, sp. nov.

Plants reddish-brown, growing in small tufts about ½in. high, branched by innovations, fastigiate. *Leaves* diaphanous, closely imbricating, lower spreading; upper nearly erect, ovate-lanceolate, acuminate, with a hyaline short hair-point, base erect, sheathing, middle leaves smaller, but otherwise similar to the upper ones, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, loosely adpressed when dry. *Perichætial leaves* very large, erect, semi-convolute, sheathing, oblong-lanceolate, tapering into a short hyaline hair-point. *Fruitstalk* short. *Capsule* immersed, ovate-oblong, mouth wide. *Peristome* single, 16, slightly bifid and minutely perforated. *Operculum* convex, with a short straight beak. *Columella* not adhering to the operculum. *Calyptra* not found.

Hab. On rocks, Broken River, Canterbury; November, 1889. Collected by R. B.

5. **Grimmia (Schistidium) mitchelli**, sp. nov.

Plants growing in small dense tufts, brownish-green, ¼in. high, branched by innovations, fastigiate. *Leaves* imbricating, erecto-patent; lower leaves ovate-lanceolate, acute; upper ones oblong-lanceolate, acute, without hyaline hair-points. *Margins* entire, recurved to near the apex, concave, keeled. *Nerve* continuous. *Areola* upper punctiform, when dry slightly crisp. *Perichætial leaves* large, erect, broadly oblong-lanceolate, acute, slightly recurved near the apex. *Fruitstalk* very short. *Capsule* immersed, broadly ovate, mouth wide. *Peristome* single, 16, irregular, perforated. *Operculum* conico-rostrate, oblique, slender. *Columella* not adherent to the operculum. *Calyptra* mitriform, entire at the base.

Hab. Damp rocks, Port Lyttelton hills; 1878: and Mount Self, near the Hurunui River; March, 1893. Collected by R. B.

6. **Grimmia (Schistidium) cyathiformis**, sp. nov.

Plants loosely tufted, brownish-green, ½in.–1in. high, branched by innovations, spreading, fastigiate. *Leaves* imbricating, diaphanous, erecto-patent; lower leaves ovate-lanceolate, obtuse; upper ones oblong-lanceolate, with a short acute hyaline point, concave. *Margins* entire. *Nerve* ending at the hyaline point. *Areola* upper punctiform, when dry erect and adpressed. *Perichætial leaves* erect, oblong-lanceolate, acute, concave. *Margins* entire, nerved, disappearing under the apex, without a hyaline point. *Fruitstalk* very short. *Capsule* cyathiform, mouth wide. *Peristome* single, 16, slender at the apex, shortly bifid or minutely perforated. *Oper-*

culum convexo-rostrate. *Beak* slender, straight. *Columella* not adherent to the operculum. *Calyptra* not found.

Hab. Damp rocks, Port Lyttelton hills; 1880: and Hurunui Gorge; March, 1893. Collected by R. B.

7. **Grimmia (Schistidium) alfredii,** sp. nov.

Plants brownish-green, growing in small tufts ¼in.–1in. high, branched by innovations, fastigiate, leaves closely imbricating, erecto-patent, diaphanous; lower leaves lanceolate, acute; upper ones ovate-lanceolate or oblong-lanceolate, tapering into a short hyaline point. *Margins* entire, recurved, concave, nerved to the hyaline point. *Areola* upper punctiform, when dry erect and adpressed to the branches. *Perichætial leaves* erect, oblong-lanceolate, tapering into a short hyaline point, concave. *Margins* entire. *Nerve* ending at the hyaline point. *Fruitstalk* very short. *Capsule* small, ovate, immersed, mouth wide. *Peristome* single, irregular, 16, minutely bifid, perforated. *Operculum* conico-rostrate, straight, about one-half the length of the capsule. *Columella* not adhering to the operculum. *Calyptra* not found.

Hab. Limestone rocks, Broken River, Canterbury; November, 1889. Collected by R. B.

8. **Grimmia (Schistidium) turbinata,** sp. nov.

Plants brownish-green, growing in small dense tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* spreading, recurved, diaphanous; lower leaves ovate-lanceolate, acute; middle ones ovate-lanceolate, tapering into a hyaline point; upper oblong-lanceolate, tapering into a hyaline point, concave. *Margins* entire. *Nerve* ending at the hyaline point. *Areola* upper punctiform, leaves nearly erect when dry. *Perichætial leaves* longer, erect, sheathing, oblong-lanceolate, tapering into a hyaline point. *Nerve* ending at the hyaline point. *Fruitstalk* as long as the capsule. *Capsule* immersed, turbinate, mouth wide. *Peristome* single, 16, perforated. *Operculum* convex, apiculate, straight. *Columella* not adhering to the operculum. *Calyptra* cucullate, lobed at the base.

Hab. Damp rocks, Port Lyttelton hills; June, 1884: and Hurunui Gorge; March, 1893. Collected by R. B.

9. **Grimmia (Schistidium) argentea,** sp. nov.

Plants growing in small greyish-white tufts ¼in. high, branched by innovations, fastigiate. *Leaves* closely imbricating, nearly erect, diaphanous; lower leaves small, linear-lanceolate, with toothed hyaline hair-point; upper ones large, broadly ovate-lanceolate, tapering into a toothed hair-point, upper half of leaf hyaline. *Margins* entire. *Nerve* running

out into the hair-point, very concave. *Areola* upper punctiform, when dry erect and adpressed. *Perichætial leaves* similar to the upper ones, sheathing the capsule. *Fruit-stalk* extremely short. *Capsule* subrotund, small, mouth wide, immersed. *Peristome* single, 16, imperfect. *Operculum* short, conico-rostrate. *Columella* not falling away, not adherent to the operculum. *Calyptra* mitriform, entire at base.

Hab. Limestone rocks, Castle Hill, Canterbury; November, 1889. Collected by R. B.

This plant appears to be very rare.

10. **Grimmia (Schistidium) wrightii,** sp. nov.

Plants small, growing in dense red-brown tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* small, closely imbricating, erecto-patent, ovate-lanceolate, acute, concave. *Margins* entire. *Nerve* continued to the apex. *Areola* upper punctiform, when dry erect and adpressed. *Perichætial leaves* erect, outer one larger than the inner, small, oblong-lanceolate, acute, shortly hyaline at the apex. *Margins* entire, concave. *Nerve* ending at the hyaline apex. *Fruitstalk* very short. *Capsule* small, shortly ovate, immersed, mouth wide. *Peristome* single, 16, imperfect. *Operculum* convexo-rostrate. *Beak* short, straight. *Columella* not falling away, not adhering to the operculum.

Hab. Limestone rocks, Broken River, Canterbury; November, 1889. Collected by R. B.

Operculum not found in three species next described.

11. **Grimmia (Schistidium) laingii,** sp. nov.

Plants reddish-brown, growing in small tufts ½in.–1in. high, branched by innovations, fastigiate. *Leaves* diaphanous, erecto-patent, closely imbricating; lower leaves ovate-lanceolate, acute, muticous or with a short hyaline point; upper ones ovate-lanceolate or oblong-lanceolate, tapering hyaline, toothed hair-point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, when dry erect, adpressed. *Perichætial* erect, narrower than the upper leaves, semi-convolute, oblong-lanceolate, tapering into a toothed hyaline hair-point. *Nerve* ending at the hair-point. *Fruit-stalk* very short. *Capsule* immersed, turbinate, mouth wide. *Peristome* single, 16, perforated or slightly bifid. *Operculum* and *calyptra* not found.

Hab. Damp rocks, Mount Torlesse; January, 1886. Collected by R. B. (named after R. M. Laing, Esq., B.Sc., President of the Philosophical Institute of Canterbury).

12. **Grimmia (Schistidium) gracilis,** sp. nov.

Plants growing in small, dense tufts, brownish-coloured, ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* closely imbricating, diaphanous, erecto-patent; lower leaves linear, tapering into a long hyaline hair-point; upper ones narrowly oblong-lanceolate or ovate-linear-lanceolate, tapering into a long slender hyaline hair-point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, slightly crisp when dry. *Perichætial leaves* shorter than the upper ones, ovate-lanceolate, tapering into a long hyaline hair-point, inner perichætial leaf smallest, concave. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* very short, slender. *Capsule* immersed, small, turbinate, mouth wide. *Peristome* single, 16, incomplete. *Operculum* and *calyptra* not found.

Hab. Limestone rocks, Broken River, Canterbury; November, 1889. Collected by R. B.

13. **Grimmia (Schistidium) minime-perichætalis,** sp. nov.

Plants dark-green, growing in small tufts, ¼in.–1in. high, branched by innovations, fastigiate. *Leaves* closely imbricating, spreading, diaphanous; lower leaves small, muticous, or with a short hyaline point; middle and upper ones oblong-lanceolate, tapering into a toothed hyaline hair-point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, erect and adpressed when dry. *Perichætial leaves* very small: inner lanceolate, acute, nerved to the apex, concave; outer larger, lanceolate, tapering into a hyaline toothed hair-point. *Margins* entire. *Fruitstalk* extremely short. *Capsule* short, subrotund, immersed, mouth wide. *Peristome* single, 16, minutely perforated. *Operculum* not found. *Calyptra* mitriform, small.

Hab. Rocks, Mount Torlesse; January, 1886. Collected by R. B.

14. **Grimmia novæ-zealandiæ,** sp. nov.

Plants dark- or yellowish-green, growing in tufts ¼in.–¾in. high, branched by innovations, fastigiate. *Leaves* erecto-patent, diaphanous; upper ones ovate-lanceolate, with a long tapering hyaline hair-point, slightly toothed, concave. *Margins* entire. *Nerve* ending at the hyaline point. *Areola* upper punctiform, slightly adpressed and erect when dry. *Perichætial leaves* one-half narrower than the upper ones, erect, linear-lanceolate, ending in a long hyaline hair-point. *Margins* entire, semi-convolute. *Nerve* ending at the hair-point. *Fruitstalk* ¼in., curved, erect, and twisted when dry. *Capsule* ovate, mouth wide. *Peristome* single, 16, slightly bifid and perforated. *Operculum* mammillate. *Calyptra* mitriform, monœcious.

Hab. Damp rocks, Port Lyttelton hills; Mount Torlesse; Stewart Island; Dunedin; West Coast. One of the commonest of this genus. Collected in these localities by R. B.

15. **Grimmia tricophylla,** var. **nigra,** var. nov.

Plants small, dark-green, growing in dense tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* closely imbricating, diaphanous, erecto-patent; lower leaves ovate-lanceolate, acute, muticous; upper ones ovate-lanceolate, narrowing towards the slender hyaline hair-point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, nearly black when dry. *Perichætial leaves* erect or long-lanceolate, narrowed into the hyaline hair-point, concave. *Margins* entire. *Nerve* disappearing at the hair-point. *Fruitstalk* decurved. *Capsule* ovate, mouth large. *Peristome* single, 16, incomplete. *Operculum* and *calyptra* not found.

Hab. Rocks in the gorge of the River Hurunui; March, 1893. Collected by R. B.

16. **Grimmia versabilis,** sp. nov.

Plants small, dark-green, growing in dense tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* spreading, upper ones erect, diaphanous, narrow-lanceolate or oblong-lanceolate, narrowed to the hyaline hair-point, very concave, keeled. *Margins* entire. *Nerve* ending at the hair-point. *Upper areola* punctiform, erect and adpressed when dry. *Perichætial leaves* smaller than the upper ones, erect, inner linear-lanceolate, outer ovate-lanceolate narrowed to the hyaline hair-point, concave. *Margins* entire, nerved to the hair-point. *Fruitstalk* decurved. *Capsule* elliptic, mouth small, annulate. *Peristome* single, 16, short, membranous. *Operculum* narrow, conico-rostrate, oblique, one-third the length of capsule. *Calyptra* small, mitriform.

Hab. Rocks, summit of Port Lyttelton hills; 1880. Collected by R. B.

17. **Grimmia finitima,** sp. nov.

Plants yellowish-green, dark below, growing in small tufts ½in. high, branched by innovations, fastigiate. *Leaves:* Lower spreading; upper nearly erect, diaphanous, ovate-lanceolate, narrowed to the hyaline hair-point; base erect, sheathing very concave, keeled. *Margins* entire. *Nerve* ending at the hair-point. *Upper areola* punctiform, erect and adpressed when dry. *Perichætial leaves* erect, smaller than the upper ones, ovate-lanceolate, narrowed to the hyaline hair-point; base of the leaves narrow. *Margins* entire, concave. *Nerve* ending at the hair-point. *Fruitstalk* decurved. *Capsule* elliptic, narrowed to the mouth, annulate. *Peristome* single, 16, bifid

to the middle. *Operculum* oblique, conico-rostrate, nearly one-third the length of the capsule. *Calyptra* not found.

Hab. Rocks, Lyttelton hills; 1880. Collected by R. B.

18. **Grimmia rotunda**, sp. nov.

Plants yellowish-green, growing in small tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* erecto-patent, diaphanous, lower leaves small, ovate-lanceolate, acute, muticous, upper ones oval, tapering to a long hyaline hair-point as long as the leaf, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, erect when dry. *Perichætial leaves* erect, as large as the upper ones, convolute, sheathing, oval. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* decurved, rotund, narrowing to the mouth. *Peristome* single, 16, upper half irregularly lobed, not bifid nor perforated. *Operculum* mammillate. *Calyptra* mitriform.

Hab. Rocks, Lyttelton hills; 1880. Collected by R. B.

19. **Grimmia obovata**, sp. nov.

Plants pale or dark-green, growing in small tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* closely imbricating, erecto-patent, diaphanous, middle and upper ones ovate-lanceolate, ending in a hyaline toothed hair-point. *Margins* entire, concave. *Nerve* ending at the hair-point. *Areola* upper punctiform, erect when dry. *Perichætial leaves* shorter than the upper ones; outer one broadly lanceolate, acuminate, with a short hyaline point; inner one smaller, concave. *Margins* entire. *Nerve* ending at the hyaline point. *Fruitstalk* decurved. *Capsule* obovate, mouth very wide. *Peristome* single, 16, short, slightly bifid at the apex. *Operculum* large, mammillate. *Calyptra* not found.

Hab. Rocks, Lyttelton hills; 1880. Collected by R. B.

20. **Grimmia belli**, sp. nov.

Plants dark-green, growing in small tufts or in large patches sometimes 2ft. or more in diameter, ¼in.–¾in. high, branched by innovations, fastigiate. *Leaves* closely imbricating, diaphanous, erecto-patent; lower ones cordate acute or obtuse, muticous; middle leaves cordate-lanceolate, ending in a strongly papillose hair-point; upper ones large, broadly oval, tapering to a hair-point. *Margins* entire, concave. *Nerve* ending at the hair-point. *Areola* upper punctiform, erect and adpressed when dry. *Perichætial* large, very concave, broadly oval, ending in a hyaline hair-point. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* erect. *Capsule* subrotund. *Peristome* single, 16, shortly bifid. *Operculum* conic, straight, half the length of the capsule. *Calyptra* mitriform.

Hab. Dry rocks, Lyttelton hills, in several places; 1882. Birdling's Flat, Lake Forsyth; Mount Self, Gorge of the Hurunui; 1893. Palmer Pass, head of the River Conway; February, 1894. Collected in these localities by R. B.

21. **Grimmia flexifolia,** sp. nov.

Plants yellow-green, growing in small tufts ½in. high, branched by innovations, fastigiate. *Leaves* diaphanous, erecto-patent, flexuous; lower ones linear-lanceolate, muticous; middle and upper oblong-lanceolate, tapering to the hyaline hair-point, semi-convolute. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, crisped when dry. *Perichætial leaves* shorter than the upper ones, linear-lanceolate, ending in a hyaline hair-point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* decurved. *Capsule* small, oblong, mouth wide. *Peristome* single, 16. *Operculum* stout, conic. *Calyptra* mitriform.

Hab. Rocks, Mount Torlesse; January, 1886. Collected by R. B.

22. **Grimmia pusilla,** sp. nov.

Plants small, reddish-brown, growing in small tufts ¼in. high, branched by innovations, fastigiate. *Leaves* small, erecto-patent, diaphanous; lower ones small, linear-lanceolate, with a hair-point; middle and upper leaves oblong-lanceolate or ovate-lanceolate, tapering to a hyaline hair-point, as long as the leaf, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform. *Leaves* erect when dry. *Perichætial* erect, inner smaller than the outer one, oblong-lanceolate, tapering to the hyaline hair-point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* decurved, $\frac{1}{16}$in. long. *Capsule* small, obovate, mouth wide. *Peristome* single, 16, entire. *Operculum* conico-rostrate, straight. *Beak* short.

Hab. On rocks, Mount Self, near the Hurunui River March, 1893. Collected by R. B.

23. **Grimmia diminuta,** sp. nov.

Plants extremely small, about $\frac{1}{32}$in. long, green, growing in small tufts, fastigiate. *Leaves* erecto-patent, middle and upper linear-lanceolate, acute or acuminate, concave. *Margins* entire. *Nerve* disappearing near the apex. *Areola* upper punctiform, erect when dry. *Perichætial leaves* erect, triangular, acute, about one-half the length of the upper ones, concave. *Margins* entire, nerved to the apex. *Fruitstalk* decurved. *Capsule* small, ovate, mouth wide. *Peristome* single, 16, incomplete. *Operculum* and *calyptra* not found.

Hab. Limestone rocks near Castle Hill, growing along with *Blindia calcarea;* March, 1891. Collected by R. B.

24. **Grimmia cockaynei,** sp. nov.

Plants yellowish-green, growing in tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* diaphanous, erecto-patent, middle and upper ones narrow-ovate or oblong-lanceolate, tapering to a short hyaline hair-point. *Margins* entire, concave. *Nerve* ending at the hair-point. *Areola* upper punctiform, erect, and adpressed when dry. *Perichætial leaves* erect, linear-lanceolate, acuminate, ending in a hyaline hair-point, semi-convolute. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* decurved. *Capsule* elliptic, mouth narrowed. *Peristome* single, 16, imperfect. *Operculum* slender, conico-rostrate, about one-half the length of the capsule. *Calyptra* mitriform.

Hab. Rocks, Mount Torlesse; January, 1886. Collected by R. B.

25. **Grimmia petriei,** sp. nov.

Plants green, growing in small tufts ¼in.–¾in. high, branched by innovations, fastigiate. *Leaves* imbricating, erecto-patent, diaphanous, middle and upper ovate-lanceolate, narrowed into a short hyaline hair-point, base erect, sheathing, keeled, concave. *Margins* entire. *Nerve* ending at the hair-point. *Areola* upper punctiform, erect when dry. *Perichætial leaves* erect, long, linear-lanceolate, ending in a short hyaline point, concave. *Margins* entire. *Nerve* ending at the hair-point. *Fruitstalk* decurved. *Capsule* ovate, symmetrical. *Peristome* small, 16, short, slender, bifid. *Operculum* short, conico-rostrate, one-third the length of the capsule. *Calyptra* mitriform, lobed at the base.

Hab. On rocks, Mount Torlesse; January, 1886. Collected by R. B.

26. **Grimmia stevensii,** sp. nov.

Plants yellowish-green, growing in tufts ¼in.–¾in. high, branched by innovations, fastigiate. *Leaves* spreading, flexuous, base erect, sheathing; lower ones linear-lanceolate; middle and upper oblong-lanceolate, narrowed to a short hyaline point, concave, keeled. *Margins* entire. *Nerve* continued to the hyaline point. *Areola* upper punctiform. *Perichætial leaves* erect, linear-lanceolate, narrowed to a short hyaline point, semi-convolute. *Nerve* ending at the hyaline point. *Margins* entire. *Fruitstalk* decurved. *Capsule* ovate, symmetrical, narrowed to the mouth. *Peristome* single, 16, imperfect. *Operculum* small, conico-rostrate, oblique. *Calyptra* narrow, mitriform.

Hab. Rocks, Mount Torlesse; January, 1886. Collected by R. B.

27. **Grimmia webbi**, sp. nov.

Plants small, dark-green, growing in tufts ¼in.–½in. high, branched by innovations, fastigiate. *Leaves* upper erecto-patent, narrowly lanceolate or oblong-lanceolate, with a short hyaline point; base erect, sheathing, concave. *Margins* entire. *Nerve* continued to the hyaline point. *Areola* upper punctiform, erect and adpressed when dry. *Perichætial leaves* erect, about one-third shorter than the upper ones, lanceolate-obtuse, concave. *Margins* entire. *Nerve* ending below the apex. Outside of the perichætial are a few longer leaves narrowed from about the middle to the base. *Nerve* ending below the apex. *Fruitstalk* decurved. *Capsule* narrowly ovate, symmetrical, annulate. *Peristome* 16, single, slender, irregular, irregularly perforated, red. *Annulus* deciduous. *Operculum* short, conic. *Calyptra* not found.

Hab. Rocks, Palmer's Pass, head-waters of the River Conway; February, 1894. Collected by R. B.

I have named this plant after H. R. Webb, Esq., F.R.M.S., a member of the Council of the Canterbury Philosophical Institute.

EXPLANATION OF PLATES XXIX.–XXXIV.

PLATE XXIX.

Figs. 1 and 2.—*Grimmia* (*Schistidium*) *aquatica.*

1. Capsule.
2. Operculum, with adherent columella.
3. Perichætial leaves.
4. Upper stem leaf.
5. Lower stem leaves.

Fig. 3.—*Grimmia* (*Schistidium*) *scarellii.*

1. Capsule.
2. Operculum, with adherent columella.
3. Perichætial leaves.
4. Stem leaves.

Fig. 4.—*Grimmia* (*Schistidium*) *apocarpa* (British).

1. Capsule, with operculum.
2. Operculum, with adherent columella.
3. Inner perichætial leaf.
4. Outer perichætial leaf.

Fig. 5.—*Grimmia* (*Schistidium*) *revisa.*

1. Capsule, with operculum.
2. Calyptra.
3. Perichætial leaves.
4. Stem leaves.

Fig. 6.—*Grimmia* (*Schistidium*) *saxitilis.*

1. Capsule.
2. Operculum.
3. Perichætial leaves.
4. Upper stem leaf.
5. Lower stem leaf.

Fig. 7.—*Grimmia* (*Schistidium*) *mitchelli.*

1. Capsule.
2. Operculum.
3. Calyptra.
4. Perichætial leaves.
5. Lower stem leaf.
6. Upper steam leaf.

Fig. 8.—*Grimmia* (*Schistidium*) *cyathiformis.*

1. Capsule.
2. Operculum.
3. Perichætial leaves.
4. Upper stem leaf.
5. Lower stem leaf.

Fig. 9.—*Grimmia* (*Schistidium*) *alfredii.*

1. Capsule.
2. Operculum.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.
7. Lower stem leaf.

Fig. 10.—*Grimmia* (*Schistidium*) *turbinata.*

1. Capsule.
2. Operculum.
3. Calyptra.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Lower stem leaf.

PLATE XXX.

Fig. 11.—*Grimmia* (*Schistidium*) *argentea.*

1. Capsule.
2. Operculum.
3. Calyptra.
4. Perichætial leaves.
5. Stem leaf.

Fig. 12.—*Grimmia* (*Schistidium*) *wrightii.*

1. Capsule, with inner perichætial leaf.
2. Operculum.
3. Outer perichætial leaf.
4. Stem leaves.

Fig. 13.—*Grimmia* (*Schistidium*) *laingii.*

1. Capsule.
2. Perichætial leaves.
3. Upper stem leaves.

Fig. 14.—*Grimmia* (*Schistidium*) *gracilis.*

1. Capsule.
2. Perichætial leaves.
3. Upper stem leaf.
4. Middle stem leaf.
5. Lower stem leaves.

Fig. 15.—*Grimmia* (*Schistidium*) *minime-perichætalis.*

1. Capsule.
2. Calyptra.
3. Perichætial leaves.
4. Upper stem leaves.
5. Middle stem leaf.

PLATE XXXI.

Fig. 16.—*Grimmia novæ-zealandiæ.*

1. Capsule.
2. Operculum.
3. Perichætial leaves.
4. Middle stem leaf.
5. Upper stem leaf.

Fig. 17.—*Grimmia pulvinata* (from British specimens).

1. Capsule.
2. Operculum.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.

Fig. 18.—*Grimmia tricophylla* (from specimens obtained from Germany).

1. Capsule, with operculum.
2. Perichætial leaves.
3. Upper stem leaf.
4. Middle stem leaf.

Fig. 19.—*Grimmia tricophylla*, var. *nigra.*

1. Capsule.
2. Perichætial leaves.
3. Upper stem leaf.
4. Middle stem leaf.

Plate XXXII.

Fig. 20.—*Grimmia versabilis.*

1. Capsule, with operculum.
2. Perichætial leaves.
3. Upper stem leaf.
4. Middle stem leaf.

Fig. 21.—*Grimmia finitima.*

1. Capsule, with operculum.
2. Perichætial leaves.
3. Outside of perichætial leaves.
4. Upper stem leaf.
5. Middle stem leaf.

Fig. 22.—*Grimmia rotunda.*

1. Capsule, with operculum.
2. Perichætial leaves.
3. Stem leaves.

Fig. 23.—*Grimmia obovata.*

1. Capsule, with operculum.
2. Perichætial leaves.
3. Upper stem leaves.

Plate XXXIII.

Fig. 24.—*Grimmia belli.*

1. Capsule, with operculum.
2. Calyptra.
3. Inner perichætial leaf.
4. Upper stem leaf.
5. Middle stem leaf.
6. Lower stem leaf.

Fig. 25.—*Grimmia flexifolia.*

1. Capsule.
2. Immature capsule, with calyptra.
3. Same with calyptra removed.
4. Inner perichætial leaves.
5. Upper stem leaf.
6. Lower stem leaf.

Fig. 26.—*Grimmia pusilla.*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Upper stem leaf.
5. Middle stem leaf.

Fig. 27.—*Grimmia diminuta.*

1. Plant, with capsule.
2. Perichætial leaves.
3. Upper stem leaves.
4. Middle stem leaves.

Plate XXXIV.

Fig. 28.—*Grimmia cockaynei.*

1. Capsule, with operculum.
2. Calyptra.
3. Perichætial leaves.
4. Middle stem leaf.
5. Upper stem leaf.

Fig. 29.—*Grimmia petriei.*

1. Capsule.
2. Operculum.
3. Calyptra.
4. Perichætial leaves.
5. Upper stem leaves.

Fig. 30.—*Grimmia stevensii.*

1. Capsule.
2. Operculum.
3. Calyptra.
4. Perichætial leaves.
5. Upper stem leaf.
6. Middle stem leaves.

Fig. 31.—*Grimmia webbi.*

1. Capsule.
2. Operculum.
3. Perichætial leaves.
4. Leaves outside of ditto.
5. Middle stem leaf.
6. Upper stem leaf.

Art. LIV.—*Notes on New Zealand Mosses: Genus* Orthotrichum.

By Robert Brown.

[*Read before the Philosophical Institute of Canterbury, 7th November, 1894.*]

Plates XXXV.–XLII.

From the following list of the genus *Orthotrichum* it will be seen that I have been enabled to collect and describe forty new species, and have still some others which I am at present keeping back by reason of insufficient material, data, &c.

There yet remain immense tracts of mountainous country in New Zealand that the foot of man has never trod, and, when systematic research in these localities is undertaken, it may confidently be expected that very many more species of this genus, as well as others, will be discovered.

In New Zealand, the species of this interesting genus are found either on trees or rocks, where a humid atmosphere surrounds them, principally in hilly or mountainous districts. They are very constant in their habitats, and particular as regards the conditions required by them. I have only thus far found two species growing on both trees and rocks—viz., *Orthotrichum brevisetum* and *O. latifolium* of this paper. A few of them have extended distribution, but by far the greater majority appear to be very local; and, until a more extensive search has taken place, it is not possible with certainty to say how or where they are distributed.

Species of this genus are found from near the sea-level to an altitude of upwards of 6,000ft., and may readily be distinguished from other mosses by their tufted habit of growth, their large mitriform calyptra (most commonly pilose), and their more or less pyriform capsules. The outer peristome has either 16 geminate or 8 bigeminate teeth. When the peristome is double the inner row consists of 8 cilia, alternating with the divisions of the outer teeth.

The colours of the calyptra and capsules in several of the species vary considerably, increasing in brightness as they approach maturity, and losing their rich red or golden colours as they fade away. Hence colour is of little value in the identification of species of this genus.

Excess of moisture is a condition which is very detrimental to the growth of the *Orthotrichum*. I had a good opportunity of verifying this fact during one of my collecting expeditions at the head of the South Fiord, Lake Te Anau, in December, 1888.

For the first twelve days there was but one dry day. It rained incessantly the whole time, both night as well as day. Dense bush covered the land from the water's edge to the line of scrub, the summit of the hills being the only portions uncovered. The prevailing cryptogamic vegetation was Hepaticæ, mosses being much less common. All were soaking with water, and growing in great luxuriance, and had been for ages. They had accumulated to a considerable depth, and the foot in walking over them left a track as if walking in snow. I saw no species of *Orthotrichum* in this locality, although constantly looking for them. They are also very rare between Milford Sound and Lake Te Anau, this also being a wet locality.

Bush-clearing has destroyed many of the habitats of this moss; but, on the other hand, where trees have been planted extensively, and allowed to remain for a number of years, new habitats have been created. As an instance of the latter, in November, 1886, I had been examining the trees in the neighbourhood of the River Avon, at Christchurch, for mosses, and on one only did I find two species. Since that period these species have extended to a large number of trees in that locality, and also to trees near the River Wairarapa, Fendalton.

Only ten New Zealand species have thus far been described or identified. Five of these are described in the "Handbook of the New Zealand Flora," viz., *O. calvum*, *O. pumilum*, *O. ruteum*, *O. crassifolium*, and *O. angustifolium*, the two last being found in Campbell Island. *O. pumilum* (from a very imperfect New Zealand specimen) has been identified as the moss of the same name growing in Europe.

From the description there given, I know I do not possess specimens of *O. crassifolium* and *O. angustifolium;* and from the brief description of the other three I am unable to identify a single plant out of my collection.

In the "Transactions and Proceedings of the New Zealand Institute," vols. xxv. and xxvi., Mr. Beckett has collected from various sources descriptions and identifications of four of the remaining five species—namely, *O. rupestre* (Sch.), *O. tasmanicum* (H. f. and W.), *O. lateciliatum* (Venturi), and *O. hortense* (Boswell). The remaining plant he (Mr. Beckett) has collected and described in vol. xxv. of the same publication, which has been named by Dr. Müller *O. graphiomitrium*. This last one I have been enabled to identify as a plant collected by me at Moa Creek, June, 1884, and since then in the bush near the River Whistler, Puketirake Range, Arthur's Pass, and Clinton Glen, head of Lake Te Anau, with this difference: that in all the specimens I have the leaves are erecto-patent and not spreading as there described. This plant has

also the longest upper leaves of any of the New Zealand species I have yet seen.

The points of difference between a very great number of species of this genus are of the most minute character, and more details should have been given in describing species of this genus (as well as others) than appears to be the case in a large number of instances. The consequence is that it is impossible to identify a large number of mosses from their meagre printed description alone, owing to the very great similarity in point of detail between one species and another.

I have therefore treated the whole of the plants collected by me as new species, with the exception of *O. graphiomitrium* (Dr. Müller). There is just a possibility of some of these being plants already discovered and described; at the same time, it is more probable that all the mosses described in this paper are new.

Section A.

Calyptra pilose. Peristome single.

1. Orthotrichum conicorostrum, *sp. nov.*
2. " pulvinatum, *sp. nov.*
3. " breve, *sp. nov.*
4. " ornatum, *sp. nov.*
5. " gracillimum, *sp. nov.*
6. " calcareum, *sp. nov.*
7. " obliquum, *sp. nov.*
8. " flexifolium, *sp. nov.*
9. " lancifolium, *sp. nov.*
10. " clintonii, *sp. nov.*
11. " inæquale, *sp. nov.*
12. " benmorense, *sp. nov.*
13. " fimbriatum, *sp. nov.*
14. " reflexum, *sp. nov.*
15. " latorum, *sp. nov.*

Section B.

Calyptra pilose. Peristome double.

16. Orthotrichum cylindrothecum, *sp. nov.*
17. " tortulosum, *sp. nov.*
18. " longithecum, *sp. nov.*
19. " anomalum, *sp. nov.*
20. " brevisetum, *sp. nov.*
21. " acuminatum, *sp. nov.*
22. " obesum, *sp. nov.*
23. " magnothecum, *sp. nov.*

Section C.

Calyptra not pilose. Peristome single.

24. Orthotrichum cyathiforme, *sp. nov.*
25. „ acutifolium, *sp. nov.*
26. „ hurunui, *sp. nov.*
27. „ minutum, *sp. nov.*
28. „ brevirostrum, *sp. nov.*

Section D.

Calyptra not pilose. Peristome double.

29. Orthotrichum avonense, *sp. nov.*
30. „ nudum, *sp. nov.*
31. „ minimifolium, *sp. nov.*
32. „ obtusatum, *sp. nov.*

Calyptra pilose. Peristome not found.

33. Orthotrichum parvulum, *sp. nov.*
34. „ arctum, *sp. nov.*

Calyptra not found. Peristome single.

35. Orthotrichum parvithecum, *sp. nov.*
36. „ latifolium, *sp. nov.*
37. „ subulatum, *sp. nov.*
38. „ erectum, *sp. nov.*
39. „ robustum, *sp. nov.*

Calyptra not found. Peristome double.

40. Orthotrichum curvatum, *sp. nov.*

Section A.

Calyptra pilose. Peristome single.

1. **Orthotrichum conicorostrum**, sp. nov.

Plants monœcious, yellowish-green, growing in small tufts ¼in.–½in. high, branched by innovations. *Branches* short, spreading. *Leaves* imbricating, spreading; lower ones small; middle and upper linear-lanceolate, tapering into an acute point from an ovate erect base, sheathing. *Margins* plain, entire, very concave. *Nerve* disappearing in the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* suberect when dry. *Perichætial leaves* erect, small, linear-lanceolate, obtuse, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* $\frac{3}{16}$in. long, capsule subpyriform, tapering into the fruitstalk. *Peristome* single, 8, bigeminate, entire. *Operculum* conic, one-third the length of the capsule. *Calyptra* as long as the capsule, mitriform, plicate, pilose.

Hab. On trees in bush near the Whistler River, Puketirake Range; December, 1888. Collected by R. B.

2. **Orthotrichum pulvinatum,** sp. nov.

Plants monœcious, dark-brown, growing in small dense tufts ¼in.–⅜in. high, branched by innovations. *Branches* very short, fastigiate. *Leaves* closely imbricating, nearly erect, very similar in outline to the lower ones, small, increasing in size upwards, ovate or oblong-lanceolate, acute, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* when dry erect and adpressed. *Perichætial leaves* erect, longer than the upper branch ones, oblong-lanceolate, acute, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* short, erect. *Capsule* immersed, shortly pyriform, slightly tapering into the fruitstalk. *Peristome* single, 8, bigeminate, irregular in the outline, perforated on the middle line, and sometimes on the lateral ones. *Operculum* conico-rostrate, straight, about half the length of the capsule. *Calyptra* mitriform, plicate, pilose.

Hab. Limestone rocks, Broken River, near Castle Hill; November, 1889. Mount Self, near the Hurunui River; March, 1893. Collected in both localities by R. B.

3. **Orthotrichum breve,** sp. nov.

Plants monœcious, dark-green at the apex, brown below, growing in very small tufts ¼in. high, branched by innovations. *Branches* very short, $\frac{1}{3}$–$\frac{1}{2}$in. long, fastigiate. *Leaves* erecto-patent, shortly imbricating, all very similar in outline, lower ones small, middle and upper ones larger, ovate-lanceolate, acute, concave. *Margins* entire, recurved from the base to near the apex. *Nerve* ending below or disappearing at the apex. *Areola:* Upper punctiform nearly to the base, lower linear-oblong. *Leaves* when dry erect. *Perichætial leaves* erect, semi-convolute, incurved near the apex, ovate-lanceolate, acute. *Fruitstalk* very short, erect. *Capsule* immersed, narrow pyriform, tapering into the fruitstalk. *Peristome* single, 8, bigeminate, entire. *Operculum* small, convex, apiculate, one-fourth the length of the capsule. *Calyptra* mitriform, plicate, pilose, as long as the capsule. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees in bush near Cooper's Nob, Port Lyttelton hills; August, 1884. Collected by R. B.

4. **Orthotrichum ornatum,** sp. nov.

Plants monœcious, reddish-brown, growing in dense pulvinate tufts ¼in.–½in. high, branched by innovations, very short, fastigiate. *Leaves* closely imbricating, erecto-patent, oblong-

lanceolate, obtuse, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Leaves* all very similar in outline, lower ones small, becoming larger upwards. *Areola* punctiform, lower oblong. *Leaves* when dry erect, and slightly twisted. *Perichætial leaves* large, erect, ovate-lanceolate, acute, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* short, erect. *Capsule* small, pyriform, immersed, tapering into the fruitstalk. *Peristome* single, 8, bigeminate, perforated on the middle line towards the base. *Operculum* convex-rostrate, about one-third the length of the capsule. *Calyptra* mitriform, covering the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Limestone rocks, Broken River, near Castle Hill; November, 1889. Collected by R. B.

Remarks.—The outline of the capsule of this plant closely resembles the figure given of the capsule of *O. crassifolium*.

5. **Orthotrichum gracillimum**, sp. nov.

Plants monœcious, dark-brown below, green at the tips, growing in small patches ½in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* small, densely imbricating, erecto-patent; lower ovate, linear-lanceolate, acute; middle and upper ones larger, semi-convolute, flexuous, ovate linear-lanceolate, acute, sheathing at the base. *Margins* entire, scarcely recurved. *Nerve* slender, keeled, ending below the apex. *Areola:* Upper punctiform, lower small quadrate. *Leaves* when dry slightly crisped. *Perichætial leaves* erect, oblong-lanceolate, acute, very concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* erect, about ¼in. long. *Capsule* exserted, narrow, pyriform, tapering into the fruitstalk. *Peristome* single, 8, bigeminate, entire. *Operculum* conico-rostrate, one-third the length of the capsule. *Calyptra* mitriform, shorter than the capsule, plicate, pilose.

Hab. Rocks, Mount Torlesse; January, 1886. Collected by R. B.

6. **Orthotrichum calcareum**, sp. nov.

Plants monœcious, dark brownish-green, growing in small dense tufts, pulvinate, ½in. high, branching by innovations. *Branches* closely arranged, short, $\frac{1}{16}$in. long, fastigiate. *Leaves* small, erecto-patent, closely imbricating, all very similar in outline, upper ones largest, ovate or oblong-lanceolate, acute, concave. *Margins* entire, plain. *Nerve* ending below the apex, slightly sheathing at the base. *Areola* upper punctiform to near the base. *Leaves* when dry erect, and adpressed. *Perichætial leaves* larger than the upper ones, erect, oblong-lanceolate, obtuse, with a short hyaline apex, concave.

Margins entire, plain. *Nerve* ending below the apex. *Fruitstalk* short, erect. *Capsule* subpyriform. *Peristome* single, 16, geminate, entire. *Operculum* conic, one-third the length of the capsule. *Calyptra* mitriform, plicate, slightly pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Limestone rocks, near Broken River; November, 1889. Collected by R. B.

7. **Orthotrichum obliquum**, sp. nov.

Plants monœcious, brownish-green, growing in loose tufts ½in.–1in. high, branched by innovations. *Branches* variable in length, subfastigiate. *Leaves* closely imbricating, erecto-patent; lower ones small, oblong-lanceolate, acute; middle and upper ones linear-lanceolate, from an ovate sheathing base, acuminate, concave. *Margins* entire, plain. *Nerve* continuous, or disappearing below the apex. *Areola:* Upper punctiform, lower linear-oblong near the base. *Leaves* when dry suberect. *Perichætial leaves* erect, shorter than the upper ones, oblong-lanceolate, acuminate, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* erect, ⅛in. long. *Capsule* exserted, pyriform. *Peristome* single, 8, bigeminate, entire. *Operculum* not found. *Calyptra* mitriform, plicate, pilose, as long as the capsule. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees near the River Teremakau; June, 1884. Collected by R. B.

8. **Orthotrichum flexifolium**, sp. nov.

Plants monœcious, yellowish-green, growing in dense pulvinate tufts ½in. to ⅝in. high, branched by innovations. *Branches* short, closely arranged. *Leaves* closely imbricating, spreading, all very similar in outline, lower ones small, upper ones larger, linear-lanceolate, from an ovate sheathing base, acuminate, flexuous, semi-convolute. *Margins* entire, plain. *Nerve* continued to the apex, keeled, slender. *Areola:* Upper punctiform, lower, linear-oblong. *Leaves* when dry very crisped. *Perichætial leaves* erecto-patent, longer than the upper ones, linear-lanceolate, obtuse, very concave. *Margins* entire, plain. *Nerve* slender, continuous. *Fruitstalk* stout, erect, ¼in. long. *Capsule* pyriform. *Peristome* single, 8, entire, bigeminate. *Operculum* conico-rostrate, straight. *Calyptra* mitriform, shorter than the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees, Clinton Glen, head of Lake Te Anau; January, 1890. Collected by R. B.

9. **Orthotrichum lancifolium,** sp. nov.

Plants monœcious, yellowish-green, growing in small tufts from ¼in. to ¾in. high, branched by innovations. *Branches* loosely spreading, short, subfastigiate. *Leaves* closely imbricating, spreading, lower and middle ones very similar in outline, linear-lanceolate, acuminate, base of the leaves clasping the stem. *Margins* entire, very recurved from the base to above the middle of the leaves, upper ones larger, ovate-oblong or ligulate, acute, twice the breadth of the middle ones, concave. *Margins* entire, not recurved, or very slightly. *Nerve* indistinct near the apex. *Areola:* Upper punctiform, lower linear-oblong. *Perichætial leaves* shorter than the upper ones, erect, ovate-lanceolate, acuminate. *Margins* entire, plain, concave. *Nerve* continued to the apex. *Fruitstalk* erect, ⅛in. long. *Capsule* oblong-pyriform, tapering into the fruitstalk. *Peristome* single, 8, bigeminate, entire. *Operculum* not found. *Calyptra* mitriform, plicate, pilose, as long as the capsule. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees, Port Lyttelton hills, Banks Peninsula; August, 1883. Collected by R. B.

10. **Orthotrichum clintonii,** sp. nov.

Plants monœcious, brownish-green, growing in loose tufts 1in.–1½in. high, branched by innovations. *Branches* spreading, short. *Leaves* erecto-patent or spreading, imbricating, lower ones linear-lanceolate, acuminate; middle and upper leaves very similar in their outline, ovate or oblong-lanceolate, tapering into an acuminate point, base sheathing. *Margins* recurved from the base to above the middle leaves; papillose, concave, nerved to the apex. *Areola:* Upper punctiform, lower oblong. *Perichætial leaves* much shorter than the upper ones, erect, oblong-lanceolate-acuminate, concave. *Margins* plain, entire. *Nerve* disappearing at the apex. *Fruitstalk* $\frac{3}{16}$in. long. *Capsule* exserted, ovate-oblong. *Peristome* single, 8, bigeminate, entire. *Operculum* mammillate. *Calyptra* mitriform, as long as the capsule, plicate, pilose. *Male inflorescence* in the axil of a leaf.

Hab. Trees near McKinnon's Pass, head of Clinton Glen; January, 1890. Collected by R. B.

11. **Orthotrichum inæquale,** sp. nov.

Plants monœcious, yellowish-green, growing in small tufts ¾in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* imbricating, erecto-patent, lower leaves small, ovate, subulate, middle and upper ones linear-lanceolate, tapering into an acute point from an erect ovate sheathing base, concave, upper leaves largest. *Margins* plain, entire. *Nerve*

keeled, disappearing in the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* when dry suberect. *Perichætial leaves* erect, sheathing, half the length of the upper ones, the lower two-thirds of the leaves oblong, the upper one-third subulate, concave. *Margins* plain, entire. *Nerve* disappearing below the apex. *Fruitstalk* $\frac{1}{3}$in. long, erect. *Capsule* exserted, pyriform, narrowed slightly to the mouth. *Peristome* single, 8, bigeminate, entire. *Operculum* not found. *Calyptra* mitriform, as long as the capsule, plicate, pilose.

Hab. Trees, Moa Creek; May, 1885. Collected by R. B.

12. **Orthotrichum benmorense**, sp. nov.

Plants monœcious, brownish-green, growing in small tufts $\frac{1}{4}$in.–$\frac{3}{4}$in. high, branched by innovations. *Branches* short, erect. *Leaves* erecto-patent, imbricating, lower ones linear-lanceolate, acute; middle and upper oblong-lanceolate or obtuse, concave, very similar in their outline. *Margins* entire, recurved from the base to near the apex. *Nerve* ending below the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* erect when dry. *Perichætial leaves* erect, about the same length as the upper ones, oblong-lanceolate, obtuse, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* short, slender, erect. *Capsule* narrow, oblong, pyriform, tapering into the fruitstalk, immersed. *Peristome* single, 8, bigeminate, entire. *Operculum* conico-rostrate, beak slender. *Calyptra* mitriform, about as long as the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf.

Hab. Twigs of scrub, northern slope of Benmore Range; May, 1885. Collected by R. B.

13. **Orthotrichum fimbriatum**, sp. nov.

Plants monœcious, yellowish-green on the tips of the branches, dark-green below, growing in tufts about $\frac{3}{4}$in. high, branched by innovations. *Branches* stout, erect, fastigiate. *Leaves* closely imbricating, erecto-patent, middle and upper ones ovate-lanceolate, acute or acuminate. *Margins* recurved from the base to near the apex, concave, nerved to the apex, strongly papillose on the upper surface of the leaves, scarious, and hispid on the margins at the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* when dry erect and nearly black. *Perichætial leaves* longer than the upper ones, erect, very concave, sheathing the capsule, ovate-lanceolate acute or obtuse. *Margins* scarious and hispid at the apex. *Fruitstalk* short, erect or slightly curved. *Capsule* immersed, ovate; mouth narrow, slightly tapering into the fruitstalk. *Peristome* single, 8 bigeminate perforated on the middle line, or 16 geminate connected at the base. *Operculum* small, convexo-rostrate. *Calyptra* mitriform, large, plicate, pilose, hairs scabrous. *Male*

inflorescence gemmaceous in the axil of a leaf below the perichætium.

Hab. Rocks, Mount Torlesse; June, 1884. Mount Herbert, Lyttelton hills, Banks Peninsula; December, 1885. Collected in these localities by R. B.

14. **Orthotrichum reflexum**, sp. nov.

Plants monœcious, yellowish-green above, dark-brown below, growing in small irregular patches ¼in.–½in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* large, erecto-patent, closely imbricating; lower ones small, ovate-lanceolate, acuminate; middle and upper leaves oblong or ovate-lanceolate, rounded at the apex. *Margins* recurved from the base to near the apex, concave. *Nerve* keeled, ending below the apex, papillose on the upper surface of the leaves and on the upper portions of the margins. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* when dry erect, and slightly twisted. *Perichætial leaves* longer than the upper ones, erect, semi-convolute, sheathing, ovate-lanceolate, subacute. *Margins* not recurved. *Nerve* ending below the apex, papillose. *Fruitstalk* short, about half the length of the capsule. *Capsule* large, pyriform immersed. *Peristome* single, 8, bigeminate, perforated on the middle line, and sometimes on the lateral ones. *Operculum* convexo-rostrate, one-third the length of the capsule. *Calyptra* shorter than the capsule, plicate, pilose, hairs scabrid. *Male inflorescence* gemmaceous in the axil of a leaf.

Hab. Rocks, Mount Torlesse; June, 1886. Collected by R. B.

15. **Orthotrichum latorum**, sp. nov.

Plants monœcious, yellowish-green above, very dark below, growing in tufts about 1in. high, branched by innovations. *Branches* spreading, fastigiate. *Leaves* closely imbricating, erecto-patent; lower ones small, oblong-lanceolate, acuminate; middle and upper leaves large, ovate-lanceolate, tapering into an acute point, concave. *Margins* entire, recurved from the base to near the apex, nerved to the apex. *Areola:* Upper punctiform, papillose; lower linear-oblong. *Leaves* erect when dry. *Perichætial leaves* shorter than the upper ones, erect, ovate or oblong-lanceolate, subacute. *Margins* entire, not recurved, concave. *Nerve* ending below the apex. *Fruitstalk* short, stout, erect, shorter than the capsule. *Capsule* large, broadly pyriform, mouth wide. *Peristome* single, 16, geminate. *Operculum* slightly convex, rostrate, beak stoutish. *Calyptra* longer than the capsule, mitriform, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf.

Hab. Rocks, Moa Creek; May, 1885. Collected by R. B.

Section B.

Calyptra pilose. Peristome double.

16. **Orthotrichum cylindrothecum,** sp. nov.

Plants monœcious, brownish-green, growing in small patches, ¼in. high, branched by innovations. *Branches* extremely short, fastigiate. *Leaves* small, closely imbricating, erecto-patent; lower ones ovate-subulate, acute; middle and upper very similar in their outline, ovate-lanceolate, tapering into an acute point, slightly falcate, concave. *Margins* entire. Sometimes a few leaves are recurved from the base to near the apex. *Nerve* continued to the apex. *Areola:* Upper punctiform; lower small, quadrate. Leaves when dry erect and adpressed. *Perichætial leaves* erect, about the same length as the upper ones, narrow, ovate-lanceolate, acute, concave. *Margins* plain, entire. *Nerve* continued to the apex. *Fruitstalk* erect, ⅛in. long, stout. *Capsule* exserted, narrow, pyriform, tapering into the fruitstalk. *Operculum* convex, apiculate, one-fourth the length of the capsule. *Peristome* double, outer 8 bigeminate, entire; inner 8 cilia alternating with the outer, consisting of two rows of cells. *Calyptra* mitriform, shorter than the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees, Mount Torlesse; January, 1886. Collected by R. B.

17. **Orthotrichum tortulosum,** sp. nov.

Plants monœcious, pale-green, growing in small tufts about ½in. high, branched by innovations. *Branches* short, spreading, fastigiate. *Leaves* closely imbricating, spreading, flexuous; middle and upper leaves nearly similar in their outline, ovate-lanceolate acute, base erect, sheathing, convolute. *Margins* plain, entire, nerved to the apex. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* very crisp when dry, *Perichætial leaves* nearly erect, much larger than the upper ones, ovate-lanceolate, tapering into an obtuse point, sheathing at the base, semi-convolute. *Margins* plain, entire, nerved to the apex. *Fruitstalk* erect, ⅛in. long. *Capsule* subpyriform, small. *Peristome* double: outer 8 bigeminate, entire or emarginate on the middle line; inner 8 cilia alternating with the outer, consisting of one single row of cells. *Operculum* stout, conico-rostrate. *Calyptra* mitriform, longer than the capsule, plicate, pilose. *Hairs* scabrid. *Male inflorescence,* gemmaceous in the axil of a leaf below the perichætium

Hab. Scrub at head of River Clinton, Otago; January, 1890. Collected by R. B.

18. **Orthotrichum longithecum,** sp. nov.

Plants monœcious, yellowish-green, growing in dense pulvinate tufts, sometimes large, ¼in.–¾in. high, branched by innovations. *Branches* closely aggregated, short, fastigiate. *Leaves* closely imbricating; lower spreading; upper nearly erect; lower ones ovate-lanceolate, obtuse, very concave; middle and upper leaves nearly similar in their outline; upper ones largest, oblong-lanceolate obtuse, semi-convolute; apex slightly cucullate. *Margins* entire, recurved from near the base to above the middle nerve, ending below the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* when dry erect and adpressed. *Perichætial* leaves about the size of the upper ones, oblong-lanceolate, acute, erect, semi-convolute. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* erect, $\frac{1}{32}$in. *Capsule* long, narrow oblong, or cylindric. *Peristome* double: outer 8 bigeminate, entire, or minutely perforated on the middle line; inner 8 cilia alternating with the outer, consisting of one row of very narrow cells half the length of the outer. *Operculum* straight, conico-rostrate, about one-quarter the length of the capsule. *Calyptra* shorter than the capsule, mitriform, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Rocks, Mount Torlesse; January, 1885. Palmer's Pass, at the head of the River Courtney; February, 1894. Collected in both localities by R. B.

19. **Orthotrichum anomalum,** sp. nov.

Plants monœcious, brownish-green, growing in loose tufts ¾in. high, branched by innovations. *Branches* stout, spreading, $\frac{1}{16}$in.–⅛in. long, fastigiate. *Leaves* closely imbricating, erecto-patent; lower ones ovate-lanceolate, tapering into an acuminate point; middle and upper similar in their outline, upper longest, oblong-lanceolate, tapering into an acuminate point sheathing at the base, very concave. *Margins* entire, recurved from the base to about the middle, papillose. *Nerve* ending below the apex. *Areola:* Upper punctiform, lower oblong-quadrate. *Leaves* when dry slightly twisted, suberect. *Perichætial leaves* shorter than the upper ones, erect, ovate-lanceolate, tapering sharply into an acuminate point, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* $\frac{3}{16}$in. long. *Capsule* long, oblong-pyriform, tapering into the fruitstalk. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia alternating with the outer, and consisting of two rows of cells, tapering from a broad base to a point. *Operculum* mammillate, small. *Calyptra* mitriform, shorter than the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees, Mount Torlesse; January, 1886. Collected by R. B.

20. **Orthotrichum brevisetum,** sp. nov.

Plants monœcious, dark-green, growing in small dense tufts ¼in. high, branched by innovations. *Branches* very short, fastigiate. *Leaves* erecto-patent, closely imbricating; lower ones oblong-lanceolate, shortly acute; middle and upper ones largest, oblong-lanceolate, subacute, concave. *Margins* entire, recurved from the base to near the apex. *Nerve* keeled, ending below the point. *Areola:* Upper punctiform, lower linear-oblong. *Perichætial leaves* smaller than the upper ones, erect, oblong-lanceolate, acute, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* very short, erect. *Capsule* large, oblong, pyriform, tapering into the fruitstalk, subimmersed. *Peristome* double: outer 8 bigeminate, entire; inner 8 slender cilia alternating with the outer ones, consisting of one row of cells as long as the outer ones. *Operculum* small, conico-rostrate, straight. *Calyptra* mitriform, shorter than the capsule, plicate, pilose, *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Rocks, Lyttelton hills; 1884: and on trees in the same locality; August, 1894. Collected by R. B.

21. **Orthotrichum acuminatum,** sp. nov.

Plants monœcious, brownish-green, growing in loose tufts from 1in. to 1½in. high, branched by innovations. *Branches* long or short, spreading, fastigiate. *Leaves* erecto-patent, closely imbricating; lower ones ovate-lanceolate, acute; middle and upper ones similar in their outline, upper largest, broad, ovate-lanceolate, tapering into a subapiculate point, concave. *Margins* plain, entire. *Nerve* continued to the apex. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* when dry erect and adpressed. *Perichætial leaves* longer than the upper ones, erect, narrow, ovate-lanceolate, tapering into an acute point, concave, sheathing. *Margins* plain, entire, nerved to the apex. *Fruitstalk* short, erect, slender at the base, thickened upwards. *Capsule* immersed, elliptic, narrowing into the mouth and tapering into the fruitstalk. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia consisting of two rows of irregular cells shorter than the outer ones and alternate with them. *Operculum* conico-rostrate, nearly one-third the length of the capsule; beak straight, slender. *Calyptra* mitriform, shorter than the capsule, plicate, slightly pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Rocks, Moa Creek, a tributary of the River Wilber-

force; May, 1885. Pukiterake Range; December, 1888. Collected by R. B.

22. **Orthotrichum obesum,** sp. nov.

Plants monœcious, yellowish-green above, brown below, growing in tufts 1½in. high. *Stems* long, slender, branched by innovations. *Branches* short, fastigiate. *Leaves* nearly erect or erecto-patent, ovate-lanceolate, tapering into an acute point, middle and upper leaves larger, upper largest, ovate-lanceolate, tapering into an acute point, concave. *Margins* plain, entire. *Nerve* disappearing at the apex. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* erect when dry. *Perichætial leaves* longer than the upper ones, erect, oblong-lanceolate, acute, concave. *Margins* plain, entire. *Nerve* disappearing at the apex. *Fruitstalk* very short, erect. *Capsule* immersed, broadly pyriform, narrowed into the mouth. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia consisting of two rows of cells shorter than the outer ones, alternating with them. *Operculum* stout, conico-rostrate, straight beak, nearly one-third the length of the capsule. *Calyptra* mitriform, shorter than the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf, below the perichætium.

Hab. Rocks, Moa Creek; May, 1885. Collected by R. B.

23. **Orthotrichum magnothecum,** sp. nov.

Plants monœcious, dark-green, growing in small tufts, ¼in.–½in. high, branched by innovations. *Branches* short, spreading, fastigiate. *Leaves* closely imbricating, spreading, lower ones ovate-lanceolate, acute or obtuse; middle and upper leaves very similar in their outline, broadly oblong-lanceolate, obtuse, concave. *Margins* entire, recurved from near the base to a little below the point. *Nerve* disappearing below the apex. *Areola:* Upper punctiform; lower narrow, oblong near the base. *Leaves* when dry suberect. *Perichætial leaves* erect, slightly broader than the upper ones, oblong-lanceolate, obtuse. *Margins* plain, entire, concave. *Nerve* ending below the apex. *Fruitstalk* erect, very short. *Capsule* large, broadly pyriform. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia composed of one row of cells as long as the outer, and alternate with them. *Operculum* large, conico-rostrate, one-third the length of the capsule. *Calyptra* mitriform, shorter than the capsule, plicate, pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees near the River Avon, and near Fendalton November, 1886. Collected in both localities by R. B.

Section C.

Calyptra not pilose. Peristome single.

24. **Orthotrichum cyathiforme**, sp. nov.

Plants monœcious, brownish-green, growing in very small tufts $\frac{3}{8}$in. high, branched by innovations. *Branches* very short, fastigiate. *Leaves* closely imbricating, spreading, or erecto-patent; lower small, narrow, lanceolate, rounded at the apex; middle and upper ones similar in their outline, upper largest, ovate-lanceolate, rounded at the apex, concave. *Margins* entire, recurved from the base to near the apex. *Nerve* keeled, ending below the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* when dry erect, and adpressed to the branch. *Perichætial leaves* shorter than the upper ones, erect, oblong-lanceolate, rounded at the apex. *Margins* plain, entire. *Nerve* ending below the apex, concave. *Fruitstalk* erect, extremely short, almost sessile. *Capsule* small, oblong, pyriform, immersed. *Peristome* single, 8, bigeminate, entire. *Operculum* not found. *Calyptra* mitriform, plicate, not pilose, shorter than the capsule.

Hab. Trees, Little River; June, 1882. Collected by R. B.

25. **Orthotrichum acutifolium**, sp. nov.

Plants monœcious, brownish-green above, dark-brown below, growing in small tufts $\frac{1}{4}$in. high, branched by innovations. *Branches* short, numerous, fastigiate. *Leaves* small, closely imbricating, erecto-patent. All the leaves are similar in their outline, lower ones smallest, subulate, acuminate from a cordate base, sheathing, concave. *Margins* entire, plain. *Nerve* disappearing in the apex. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* when dry nearly erect. *Perichætial leaves* about as long as the upper ones, erect, oblong-lanceolate, acute, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* erect, $\frac{1}{8}$in. long. *Capsule* exserted, oblong-pyriform, tapering slightly into the fruitstalk. *Peristome* single, 8, bigeminate, entire. *Operculum* conico-rostrate, about one-fifth the length of the capsule. *Calyptra* mitriform, not pilose, plicate.

Hab. Trees near the River Teremakau; June, 1884: and Moa Creek; May, 1885. Collected in these localities by R. B.

26. **Orthotrichum hurunui**, sp. nov.

Plants monœcious, dark-green, growing in small dense tufts $\frac{3}{8}$in. high, branched by innovations. *Branches* short, $\frac{1}{16}$in., fastigiate. *Leaves* spreading from an erect base, closely imbricating; lower ones linear-lanceolate, acute, sheathing at the base; middle and upper ones similar in their outline, ovate-lanceolate, obtuse, concave, slightly hooded at the apex.

Margins plain, entire. *Nerve* ending below the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* crisp when dry. *Perichætial leaves* slightly shorter than the upper ones; outer one ligulate, rounded at the apex; inner one ligulate from an ovate sheathing base, rounded at the apex, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* inclined, $\frac{1}{8}$in. long. *Capsule* shortly ovate, exserted, annulate. *Peristome* single, 16, geminate, perforated on the middle line. *Operculum* conico-rostrate, beak very long, nearly as long as the capsule. *Calyptra* mitriform, plicate, not pilose, longer than the capsule. *Male inflorescence* gemmaceous, situated on the perichætium.

Hab. Dry rocks, gorge of the Hurunui River; March, 1893. Collected by R. B.

27. **Orthotrichum minutum,** sp. nov.

Plants monœcious, brownish-green, growing in very small dense tufts from $\frac{3}{16}$in. to $\frac{1}{4}$in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* small, erecto-patent or spreading at the top of the branch; lower ones small, linear-lanceolate, acute; middle and upper very similar in their outline, linear-lanceolate, subacute, flexuous; base erect, sheathing, concave. *Margins* plain, entire. *Nerve* continued to the apex. *Areola:* Upper punctiform, lower linear-oblong. *Leaves* crisp when dry. *Perichætial leaves* erect; outer one largest, oblong-lanceolate, rounded to an obtuse point, concave. *Margins* plain, entire. *Nerve* continued to the apex. *Fruitstalk* short, slender, erect. *Capsule* small, pyriform, tapering into the fruitstalk. *Peristome* single, 8, bigeminate, entire. *Operculum* not found. *Calyptra* mitriform, as long as the capsule, plicate, not pilose.

Hab. Trees, Lyttelton hills; September, 1888. Collected by R. B.

28. **Orthotrichum brevirostrum,** sp. nov.

Plants monœcious, green above, very dark below, growing in small tufts $\frac{3}{8}$in. high, branched by innovations. *Branches* short, $\frac{3}{16}$in. long, fastigiate. *Leaves* closely imbricating, erecto-patent; lower and middle ones similar in their outline, becoming larger upwards, broadly ovate-lanceolate, rounded at the apex, concave. *Margins* entire, recurved from the base to near the apex, papillose. *Nerve* keeled, ending below the apex; upper leaves larger than the middle ones, but not recurved on the margin, otherwise similar. *Areola:* Upper punctiform to near the base, lower linear-oblong. *Leaves* when dry erect. *Perichætial leaves* erect, smaller than the upper ones, oblong-lanceolate, rounded at the apex. *Margins* entire, not recurved, concave. *Nerve* ending below the top. *Fruit-*

stalk short, erect. *Capsule* immersed, large, oblong, pyriform, narrowed slightly to the mouth. *Peristome* single, 8, bigeminate. *Operculum* small, short, conico-rostrate. *Calyptra* mitriform, about half the length of the capsule, plicate, not pilose.

Hab. Rocks, Lyttelton hills; September, 1888. Collected by R. B.

SECTION D.

Calyptra not pilose. Peristome double.

29. **Orthotrichum avonense,** sp. nov.

Plants monœcious, light-green, growing in small tufts about $\frac{1}{4}$in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* erecto-patent, imbricating, small. *Leaves* very similar in their outline, the upper being largest, linear-lanceolate from an ovate erect sheathing base, acute, concave. *Margins* plain, entire. *Nerve* keeled, continued to the apex. *Areola* punctiform to near the base. *Leaves* erect when dry. *Perichætial leaves* very small, erect, oblong-lanceolate, acute, concave. *Margins* entire, plain. *Nerve* continued to the apex. *Fruitstalk* nearly erect, $\frac{1}{8}$in. long. *Capsule* small, exserted, pyriform, tapering into the fruitstalk, mouth wide. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia consisting of one row of slender cells nearly as long as the outer teeth. *Operculum* large, conic, acute, about one-half the length of the capsule. *Calyptra* mitriform, as long as the capsule, plicate, not pilose.

Hab. Trees near River Avon; November, 1886. Collected by R. B.

30. **Orthotrichum nudum,** sp. nov.

Plants monœcious, yellowish-green above, brown below, growing in small loose tufts from $\frac{1}{4}$in. to $\frac{3}{4}$in. high, branched by innovations. *Branches* spreading, subfastigiate. *Leaves* imbricating, spreading, oblong-lanceolate, acute; middle and upper ones larger but otherwise similar in their outline, oblong-lanceolate, acute, sheathing at the base, concave. *Margins* plain, entire. *Nerve* disappearing in the apex. *Areola:* Upper punctiform; lower small, oblong. *Leaves* slightly crisped when dry. *Perichætial leaves* smaller than the upper ones, oblong-lanceolate, acute, concave. *Margins* plain, entire. *Nerve* disappearing in the apex. *Fruitstalk* $\frac{1}{16}$in. long, erect. *Capsule* subimmersed, pyriform. *Peristome* double: outer 16 geminate, entire; inner 16 cilia consisting of one row of cells as long as the outer teeth. *Operculum* stout, conico-rostrate, beak short. *Calyptra* as long as the capsule, mitriform, plicate, not pilose. *Male inflorescence* gemmaceous in the axil of a leaf.

Hab. Twigs, Mount Torlesse; January, 1886. Collected by R. B.

31. **Orthotrichum minimifolium,** sp. nov.

Plants monœcious, brownish-green, growing in small dense tufts $\frac{1}{4}$in. high, branched by innovations. Branches short, fastigiate. *Leaves* spreading, closely imbricating; lower ones small, linear-lanceolate, subacute; middle and upper leaves very similar in their outline, linear-lanceolate, subacute, base erect, sheathing, semi-convolute. *Margins* entire, plain. *Nerve* ending below the apex. *Areola:* Punctiform upper, lower linear-oblong. *Perichætial leaves:* Inner ovate-subulate; outer longer, ovate-subulate. *Nerve* ending below the apex. *Margins* entire, plain. *Fruitstalk* erect, short. *Capsule* small, immersed, ovate-oblong. *Peristome* double: outer 8 bigeminate, entire, or perforated in the middle line, and occasionally on the lateral ones; inner 8 cilia consisting of one slender row of cells nearly as long as the outer and alternating with them. *Calyptra* as long as the capsule, mitriform, plicate, not pilose. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Rocks, Moa Creek; May, 1885. Collected by R. B.

32. **Orthotrichum obtusatum,** sp. nov.

Plants monœcious, brownish-green, growing in small tufts $\frac{1}{2}$in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* erecto-patent, imbricating, lower and middle ones small, upper large, all very similar in their outline, broadly ligulate, and round at the apex; base erect, sheathing, concave. *Margins* plain, entire. *Nerve* ending below the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* when dry suberect. *Perichætial leaves* larger and longer than the upper ones, oblong-lanceolate, acute. *Nerved* to the apex. *Margins* entire, plain. *Fruitstalk* short, erect. *Capsule* small, ovate, tapering slightly into the fruitstalk, immersed. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia alternate with the outer ones, and consisting of one row of cells, shorter than the outer teeth. *Operculum* conico-rostrate, one-third as long as the capsule; beak short. *Calyptra* smaller than the capsule, plicate, not pilose.

Hab. Rocks, Moa Creek; May, 1885. Collected by R. B.

Calyptra pilose. Peristome not found.

33. **Orthotrichum parvulum,** sp. nov.

Plants brownish-green, growing in very small tufts $\frac{3}{16}$in. high, branched by innovations. *Branches* less than $\frac{1}{16}$in. long, subfastigiate. *Leaves* closely imbricating, small, erecto-

patent; lower ones ovate, tapering into a subulate apex; middle leaves larger, lower half of leaves ovate, upper portion narrow-lanceolate, acute; upper ones cordate, then narrow lanceolate acute; base of the leaves broad, concave. *Margins* entire, plain. *Nerve* keeled, ending below the apex. *Areola:* Upper punctiform; lower small, oblong. *Leaves* erect when dry. *Perichætial leaves* longer than the upper ones, erect, oblong-lanceolate, subacute, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* erect, about $\frac{1}{16}$in. long. *Capsule* exserted, small, pyriform, tapering into the fruitstalk. *Peristome* and *operculum* not found. *Calyptra* mitriform, plicate, pilose, monœcious. *Male inflorescence* in the axil of a leaf below the perichætium.

Hab. Trees at Moa Creek; May, 1885. Collected by R. B.

34. **Orthotrichum arctum**, sp. nov.

Plants monœcious, brownish-green, growing in small tufts $\frac{1}{2}$in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* closely imbricating, erecto-patent; lower ones oblong-lanceolate, obtuse; middle and upper nearly similar in outline, broadly lanceolate, rounded at the apex, concave. *Nerve* keeled, ending below the apex. *Margins* entire, plain. *Areola:* Upper punctiform, lower quadrate. *Leaves* when dry erect and adpressed. *Perichætial leaves* shorter than the upper ones, erect, broadly ovate-lanceolate, rounded at the apex, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* short, erect, $\frac{1}{16}$in. long. *Capsule* pyriform, immersed. *Peristome* very imperfect, single (?), 8, bigeminate. *Operculum* not found. *Calyptra* mitriform, plicate, pilose, as long as the capsule.

Hab. On trees, Little River, Banks Peninsula; June, 1882. Collected by R. B.

35. **Orthotrichum parvithecum**, sp. nov.

Plants monœcious, yellowish-green, growing in loose tufts 1in. high, branched by innovations. *Branches* unequal in height. *Leaves* spreading, imbricating, linear-lanceolate from an ovate sheathing base, acute, concave. *Nerve* keeled, disappearing in the apex. *Margins* entire, plain; all the branch leaves are very similar in outline, the lower being slightly smaller than the upper ones. *Areola:* Upper punctiform; lower small, narrow, oblong. *Leaves* finely crisped when dry. *Perichætial leaves* smaller than the upper ones, the innermost being the smallest, erect, ovate or oblong-lanceolate, acute. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* erect, $\frac{1}{8}$in. long. *Capsule* exserted, small, ovate, tapering slightly into the fruitstalk. *Peristome* single,

8, bigeminate, entire. *Operculum* and *calyptra* not found. *Male inflorescence* on separate branches.

Hab. Trees, Clinton Glen, head of Lake Te Anau; January, 1889. Collected by R. B.

36. **Orthotrichum latifolium,** sp. nov.

Plants monœcious, brownish-green or dark-green, growing in small dense tufts ¼in.–⅜in. high, branched by innovations. *Branches* very short. *Leaves* erecto-patent, closely imbricating; middle leaves large, oblong-lanceolate, rounded to a subapiculate point; upper larger, very broadly ovate-lanceolate, rounded to a subapiculate point, base erect, sheathing, concave. *Margins* recurved from the base to above the middle. *Nerve* continued to the apex. *Areola:* Upper punctiform, lower oblong. *Leaves* when dry erect. *Perichætial* shorter and narrower than the upper leaves, erect, oblong-lanceolate, acute, concave. *Margins* plain, entire. *Nerve* continued to the apex. *Fruitstalk* very short. *Capsule* ovate-oblong, immersed. *Peristome* single, 8, bigeminate, entire. *Operculum* and *calyptra* not found.

Hab. Trees and rocks, Mount Torlesse; January, 1886. Collected by R. B.

37. **Orthotrichum subulatum,** sp. nov.

Plants monœcious, yellow-green at the top of the branches, dark-brown below, growing in loose tufts 1in. to 1¼in. high, branched by innovations. *Branches* spreading, unequal, long or short. *Leaves* closely imbricating, erecto-patent, all very similar in outline, the upper ones being largest, cordate, subulate, acute, base sheathing. *Margins* plain, entire, and concave. *Nerve* disappearing in the apex. *Areola:* Upper punctiform, lower quadrate. *Leaves* when dry spreading from a sheathing base. *Perichætial leaves* much larger than the upper ones, erect, ovate-lanceolate, obtuse, concave. *Margins* entire, plain. *Nerve* ending below the apex. *Fruitstalk* erect, ¼in. long. *Capsule* exserted, pyriform, tapering into the fruitstalk *Peristome* single, 8, bigeminate, entire. *Operculum* and *calyptra* not found. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. Trees in bush, near the River Teremakau; June, 1884. Collected by R. B.

38. **Orthotrichum erectum,** sp. nov.

Plants monœcious, brownish-green, growing in small tufts ⅜in. high, branched by innovations. *Branches* loose, spreading, fastigiate. *Leaves* closely imbricating, erecto-patent; lower ones narrow, linear-lanceolate, acuminate from an

ovate sheathing base; middle and upper linear-lanceolate, acuminate, base ovate, sheathing, concave. *Margins* entire, recurved from the base to a little above the middle. *Nerve* keeled, disappearing in the apex. *Areola:* Upper punctiform; lower small, linear-oblong. *Leaves* crisp when dry. *Perichætial* leaves erect, longer than the upper ones, linear-lanceolate from an ovate base, acuminate, concave. *Margins* not recurved, entire. *Nerve* disappearing in the apex. *Fruitstalk* straight. *Capsule* large, pyriform, tapering into the fruitstalk. *Peristome* single, 8, bigeminate. *Operculum* and *calyptra* not found. *Male inflorescence* gemmaceous in the axil of a leaf below the perichætium.

Hab. On trees near Castle Hill; November, 1889. Collected by R. B.

39. **Orthotrichum robustum**, sp. nov.

Plants monœcious, dark-green, growing in small tufts, ¼in.–⅜in. high, branched by innovations. *Branches* short, fastigiate. *Leaves* closely imbricating, spreading; lower ones oblong-lanceolate, acute; middle and upper ones very similar in their outline, upper largest, ovate, lanceolate, acute, very concave. *Margins* entire, recurved from the base to above the middle. *Nerve* ending below the apex. *Areola:* Upper punctiform, lower oblong-quadrate. *Leaves* erect and adpressed to the branch when dry. *Perichætial* leaves erect, as long as the upper ones, nearly convolute, oblong-lanceolate, acute, sheathing. *Margins* plain, entire. *Nerve* ending below the apex. *Fruitstalk* erect, short. *Capsule* large, subimmersed, ovate, oblong. *Peristome* imperfect, only the base of the outer remaining, 8, bigeminate. *Operculum* and *calyptra* not found.

Hab. Rocks, West Coast Road; June, 1884. Collected by R. B.

40. **Orthotrichum curvatum**, sp. nov.

Plants monœcious, light-green above, dark-brown below, growing in small tufts ¾in. high, branched by innovations. *Branches* loose, spreading, slender, fastigiate. *Leaves* imbricating, erecto-patent or spreading; lower ones small, linear-lanceolate from an ovate base, acute; middle and upper leaves very similar in their outline, linear-lanceolate, obtuse; base erect, sheathing, semi-convolute. *Nerve* keeled, disappearing below the apex. *Margins* plain, minute, papillose. *Areola:* Upper punctiform; lower narrow, oblong. *Leaves* when dry suberect. *Perichætial leaves* shorter than the upper ones, erect, sheathing; outer ligulate from the middle, and rounded at the apex, lower half ovate; inner one much broader and shorter than the outer one, ovate, rounded at the apex, semi-convolute. *Nerve* ending below the apex.

Fruitstalk erect, ½in. long. *Capsule* ovate-oblong, exserted. *Peristome* double: outer 8 bigeminate, entire; inner 8 cilia consisting of two rows of cells, alternating with the outer teeth. *Operculum* and *calyptra* not found. *Male inflorescence* gemmaceous in the axil of a leaf.

Hab. Rocks, Mount Torlesse; January, 1886. Collected by R.B.

EXPLANATION OF PLATES XXXV.–XLII.

Plate XXXV.

Fig. 1.—*Orthotrichum conicorostrum.*

1. Capsule and operculum.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Outside the perichætial leaf.
7. Upper stem leaf.
8. Middle stem leaf.

Fig. 2.—*Orthotrichum pulvinatum.*

1. Capsule.
2. Operculum.
3. Peristome.
4. Calyptra from immature plant.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7. Upper stem leaf.

Fig. 3.—*Orthotrichum breve.*

1. Capsule and operculum.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Stem leaf (upper).

Fig. 4.—*Orthotrichum ornatum.*

1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Middle stem leaf.

Fig. 5.—*Orthotrichum gracillimum.*

1. Capsule (scarcely matured).
2. Calyptra.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Outside the perichætial leaf.
6. Upper stem leaf.
7. Lower stem leaf.
8. Peristome.

Plate XXXVI.

Fig. 6.—*Orthotrichum calcareum.*

1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7. Upper stem leaf.
8. Middle stem leaf.

Fig. 7.—*Orthotrichum obliquum.*

1. Capsule.
2. Calyptra.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.

Fig. 8.—*Orthotrichum flexifolium.*

1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Middle stem leaf.
8. Lower stem leaf.

Fig. 9.—*Orthotrichum lancifolium.*

1. Capsule.
2. Calyptra.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Outside the perichætial leaf.
6. Middle stem leaf.

Fig. 10.—*Orthotrichum clintonii.*

1. Capsule.
2. Immature operculum.
3. Calyptra.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Male inflorescence.
7. Upper stem leaf.
8. Upper stem leaf.

PLATE XXXVII.

Fig. 11.—*Orthotrichum inæquale.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Outside the perichætial leaf.
7. Upper stem leaf.
8. Middle stem leaf.

Fig. 12.—*Orthotrichum benmorense.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Perichætial leaf.
6. Upper stem leaf.
7. Lower stem leaf.
8. Leaf from inflorescence.

Fig. 13.—*Orthotricum fimbriatum.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Middle stem leaf.

Fig. 14.—*Orthotricum reflexum.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.

Fig. 15.—*Orthotricum latorum.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Upper stem leaf.
7. Lower stem leaf.

PLATE XXXVIII.

Fig. 16.—*Orthotricum cylindrothecum.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Lower stem leaf.

Fig. 17.—*Orthotrichum tortulosum.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7, 8. Stem leaves.

Fig. 18.—*Orthotrichum longithecum.*
1. Capsule.
2. Calyptra.
3. Operculum.
4. Inner perichætial leaf.
5. Upper stem leaf.
6. Upper stem leaf.
7. Lower stem leaf.

Fig. 19.—*Orthotrichum anomalum.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7, 8. Upper stem leaves.

Fig. 20.—*Orthotrichum brevisetum.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7. Upper stem leaf.
8. Lower stem leaf.

PLATE XXXIX.

Fig. 21.—*Orthotrichum acuminatum.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Upper stem leaf.

Fig. 22.—*Orthotrichum obesum.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7. Upper stem leaf.

Fig. 23.—*Orthotrichum magnothecum.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.

Fig. 24.—*Orthotrichum cyathiforme.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Lower stem leaf.

Fig. 25.—*Orthotrichum acutifolium.*
1. Capsule.
2. Capsule and operculum (immature).
3. Calyptra (immature).
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7. Upper stem leaf.
8. Middle stem leaf.
9. Lower stem leaf.

Plate XL.

Fig. 26.—*Orthotrichum hurunui.*
1. Capsule.
2. Capsule with operculum scarcely mature.
3. Calyptra.
4. Peristome.
5. Inflorescence.
6. Inner perichætial leaf.
7. Outer perichætial leaf.
8. Upper stem leaf.

Fig. 27.—*Orthotrichum minutum.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Middle stem leaf.

Fig. 28.—*Orthotrichum brevirostrum.*
1. Capsule and operculum.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Middle stem leaf.

Fig. 29.—*Orthotrichum avonense.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf.
5. Outer perichætial leaf.
6. Upper stem leaf.
7. Middle stem leaf.
8. Lower stem leaf.

Fig. 30.—*Orthotrichum nudum.*
1. Capsule.
2. Calyptra.
3. Peristome.
4. Inner perichætial leaf *in situ*.
5. Outer perichætial leaf *in situ*.
6. Upper stem leaf.
7. Middle stem leaf.

Fig. 31.—*Orthotrichum minimifolium.*
1. Capsule.
2. Operculum.
3. Calyptra.
4. Peristome.
5. Inner perichætial leaf.
6. Outer perichætial leaf.
7. Upper stem leaf.
8, 9. Middle stem leaves.

Plate XLI.

Fig. 32.—*Orthotrichum obtusatum.*
1. Capsule, with inner perichætial leaf *in situ*.
2. Operculum.
3. Calyptra.
4. Peristome.
5, 6. Upper stem leaves.
7. Middle stem leaf.
8. Lower stem leaf.

Fig. 33.—*Orthotrichum parvulum.*
1. Capsule.
2. Calyptra.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.
7. Lower stem leaf.

Fig. 34.—*Orthotrichum arctum.*
1. Capsule.
2. Calyptra.
3. Inner perichætial leaf.
4. Upper stem leaf.
5. Lower stem leaf.

Fig. 35.—*Orthotrichum parvithecum.*
1. Capsule.
2. Peristome.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.

Fig. 36.—*Orthotrichum latifolium.*
1. Capsule.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside the perichætial leaf.
5. Upper stem leaf.

PLATE XLII.

Fig. 37.—*Orthotrichum subulatum.*
1. Capsule.
2. Peristome.
3. Inner perichætial leaf.
4. Outer perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.
7. Lower stem leaf.

Fig. 38.—*Orthotrichum erectum.*
1. Capsule.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Upper stem leaf.
5. Middle stem leaf.

Fig. 39.—*Orthotrichum robustum.*
1. Capsule.
2. Inner perichætial leaf.
3. Outside the perichætial leaf.
4. Upper stem leaf.

Fig. 40.—*Orthotrichum curvatum.*
1. Capsule.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Upper stem leaf.
5. Middle stem leaf.

ART. LV.—*On the Growth of Ferns; and on a New Fern now first reported.*

By H. C. FIELD.

[*Read before the Wellington Philosophical Society, 17th October, 1894.*]

ON the 2nd March I received a letter from Mr. James Patterson, of the Thames, informing me that some miles inland, and at an elevation of 1,725ft. above sea-level, he had found a tree-trunk covered to the height of 12ft. or 14ft. by an *Asplenium*, which climbed by means of fleshy creeping rhizomes similar to those of *Polypodium billardieri*. He also stated that he had found what he believed to be the same variety close to the coast, and at an altitude of only about 50ft. As no such widely-creeping *Asplenium* had been reported in the colony I was naturally interested in the discovery, and a few days later I received a parcel of specimens of the fern. On inspecting them I found that their long, straight sori, and the peculiar dark bluish-green colour of the

fronds, seemed to mark them unmistakably as *Asplenium obtusatum*, var. *lyallii*, particularly of that form of it with indented edges, approximating to *A. bulbiferum*. The specimens had no rhizomes attached, and I therefore felt doubtful whether there had not been some mistake about them —whether, in fact, they might not have belonged to some other fern. I wrote to several fern-collectors, and found that they knew nothing of such a plant, and Mr. Cheeseman, in particular, thought there was a mistake about it. The matter, however, was settled by my receiving from Mr. Patterson several weeks ago half a dozen live plants, with unmistakable creeping rhizomes, such as he described, and one of them with a lateral rhizome branching out from the main one. Mr. Patterson stated that he obtained them from off the face of a sloping rock, about 15ft. high by 12ft. broad, which was covered with them. Var. *lyallii* has never, I believe, been hitherto reported from any locality north of Wellington. It is usually an exclusively terrestrial plant, and has less of the creeping tendency than any other form of *Asplenium obtusatum;* in fact, it usually produces only a crown of fronds on the top of an erect rhizome, though in very old plants it is not unusual to find lateral crowns surrounding the main one. In every case, however, each year's fronds grow close together, and closely on top of the dying fronds of the previous year. The root-fibres, too, start from below the original crown, though it is possible that in some cases where soil has accumulated round the rhizome further fibres may be produced above the level of the earliest fronds. In the plants sent me by Mr. Patterson, however, the fronds grow singly, ½in. to 1in. asunder, and only from the upper or outer half of the circumference of the rhizome; while the root-fibres (rather long ones) grow from the other half. Such a strange departure from the usual habit of the plant has naturally set me considering the whole question of the growth of ferns, and I have arrived at some conclusions which I think are new, and may therefore be worth stating. This is not the only instance in which there seems a change of habit of growth in these plants according to the conditions under which they are found. The other forms of *Asplenium obtusatum*, as I have mentioned, all have a tendency to creep slightly and slowly, and this development of the habit in var. *lyallii* indicates that the plant was properly classed, which had till now been doubtful. *Asplenium umbrosum* also creeps slowly, and the small variety of it reported from Nelson several years ago by Mr. Kirk, sen., spreads very distinctly and rapidly. *Lomaria procera* and *Polypodium pennigerum* also creep occasionally. I used to fancy that the rhizomes had been bent down by accident, and so forced to grow more

or less horizontally. In February, 1892, I found, in a patch of bush behind Waikanae, a number of plants of *Nephrodium glabellum*, which had unmistakably assumed the creeping habit of growth; and I thought that they, or the original plant from which they sprang, might have been hybridized with *Nephrodium decompositum*, which is plentiful in the vicinity. Last week, again, in removing the dead fronds from a plant of *Nephrodium velutinum*, I found that it had travelled several inches from where it was planted, and had nearly reached the side of the pot. *Alsophila colensoi* and *Dicksonia lanata* seem unquestionably also occasionally to assume erect habits of growth, instead of their ordinary creeping one, though I myself have never met with any examples which did so.

On careful consideration, it seems to me that the apparently divergent habits of growth in ferns may possibly be merely modifications of a common habit, rather than really different ones. All ferns on emerging from the prothallus stage produce their first fronds from a bud, which rapidly assumes the form of a short, erect rhizome. Some seem to retain this habit all through their lives, or only produce lateral crowns around the main one on attaining age. In other cases the erect rhizome becomes elongated into a caudex, sometimes of considerable height, with the crown of fronds on top. Some of these tree-ferns, particularly in certain localities, often become branched, and produce several crowns. The late Mr. J. Buchanan some years ago reported one near Dunedin with no less than sixteen branches and crowns. Others again, and particularly *Dicksonia squarrosa*, often have lateral crowns growing out from the sides of their caudices. I used to think that these were separate plants which had grown from spores that had lodged in the fibrous outer surface of the caudex; but I am now more disposed to think that they are actual lateral growths from the parent plant. Other ferns, even from what may be called their seedling stage, produce lateral creeping rhizomes, which throw out secondary rhizomes, and by thus branching soon overspread considerable areas. It seems to me, therefore, that the ramifying habit of growth is really the normal one, though it, in many species, only becomes developed at a late stage in the life of the plant—that, in fact, the branches and lateral crowns are merely developments of the creeping habit, which have been produced at too late a stage and too high above the ground for actual creeping to occur. It is a point that is worth study by those who have time and opportunity, and therefore I mention it. In this case the separate solitary fronds which grow from creeping rhizomes at short distances merely represent those which

grow closely together so as to form crowns on top of erect rhizomes; and the aerial roots which surround the caudices of tree-ferns are merely the counterparts of those which, in creeping varieties, descend into the soil and sustain the life of the plant.

In the letter which I received on the 2nd March Mr. Patterson also sent me a pinna and an impression (evidently produced by a copying-press and then traced round with a sharp pencil) of a small frond of what he thought was a *Lygodium*. He said that he had received the specimens from a Mrs. Wilson, of Christchurch, who had gathered them at Rotorua. On writing to that lady she informed me that she first saw a specimen of the plant twined round the hat of a Maori in the telegraph-office at Rotorua; that she got him to allow her to examine it; and that a few days later she and her daughter found the plant growing plentifully in a locality at Waiwera, which she described. I naturally concluded that Waiwera was some part of Rotorua, or close to it, though I did not know any place thereabouts bearing the name, and people who had lived at Ohinemutu for several years were equally ignorant of it. I have since learnt that Mrs. Wilson meant the watering-place north of Auckland. Along with her reply she most kindly sent me a specimen of the fern—a spray nearly 2ft. long, from which I found that there could be no question as to the plant being a *Lygodium*, and different from any described in the "Synopsis Filicum." Mrs. Wilson said that she found the plant about eleven years ago, and only gathered specimens to press, but that she afterwards procured three plants, one of which she gave to Mr. Patterson, and still had the other two. She has since sent me a rooted offset from one of her plants, which is now producing two fresh fronds. Mr. Patterson also writes that there are three new fronds on his plant, so that the present existence of the species is beyond doubt. It is rather remarkable that, of so small a class as *Lygodium*, a second species should turn up in New Zealand, and that both should be quite distinct from any found elsewhere. The only one described in the "Synopsis Filicum" which at all resembles the new one is *L. palmatum*, of the eastern States of North America; but even this differs in the length of the secondary petioles; in the shape of the ultimate pinnules, these being wider than they are long, while those of the new plant are the reverse; and in being merely pinnate, while the new one is very distinctly bipinnate in the lower and larger pinnæ. The plant seems to vary a good deal in the relative proportions of its several parts. Generally stated, however, the primary petioles are short, the secondary ones long (sometimes more than an inch), and the third ones short or medium: these, as well as

the centre stem of the frond, or rather spray, are of a yellowish-brown colour. The pinnæ divide generally into three pinnules—two lateral ones placed alternately and stalked or narrowly webbed, and a terminal one. These pinnules are from 1¼in. to 1½in. long by ¾in. broad, palmately and very deeply cut into long, narrow, ovately-pointed lobes. Their edges are very finely and rather deeply serrated; the veins numerous, free, and forked; texture extremely thin, and almost diaphanous; colour, shining yellowish-green.

Mr. Cheeseman seems very doubtful whether the plant is really a native of New Zealand, and I have sent him the specimen given me by Mrs. Wilson, in order that he may ascertain whether such a fern is known to nurserymen and others at Auckland, or to persons who have visited the Pacific Islands. The reason for his doubt appears to be the improbability of so lovely a plant having escaped notice, in localities so much visited as Rotorua and Waiwera, and, if it occurs at places so wide asunder, its not having been met with in the intervening country. But then the question naturally arises, If it is not a New Zealand plant, whence has it come? Mrs. Wilson, in a postscript to her first letter to me, says that it was mentioned by Mr. Dobie, in his book published several years ago, under the name of *Pteris dichotoma;* but no fern of that name is described in the "Synopsis." Unfortunately, neither of the specimens which I have seen, or of which I can obtain particulars, is fertile; so that I am unable to describe the fructification, which, however, judging by the resemblance of the fern to *Lygodium palmatum*, will probably consist of merely linear divisions, carrying the capsules on their sides.

The accompanying specimen is a very shabby one, but it is the best which I have available; and, at all events, it will serve to show the character of the fern, which is of a different family of *Lygodium* from *L. articulatum*.

III.—GEOLOGY.

Art. LVI.—*On the Hawke's Bay Pleistocene Beds and the Glacial Period.*

By H. Hill, F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 9th July and 12th November, 1894.*]

Plates XLIII. and XLIV.

Part I.

At the upper end of Sturm's Gully, in the Town of Napier, and about 200ft. above sea-level, is a quarry that was opened several years ago by the contractors who are engaged in the construction of an artificial breakwater for the Port of Napier. The area known as Scinde Island on the maps, and on which the quarry is situated, is composed of limestones about the age of which much difference of opinion has been expressed. The limestones consist of an upper and a lower series, separated by fossiliferous grey and blue marls of varying material and thickness. In places the upper limestone has disappeared; in others it remains as large indurated blocks with a curiously smooth and rounded surface, and pitted here and there with holes which are filled with a brown mud-like material. This rounded and smooth surface is only noticed after the overlying beds of loessic clay and soil have been cleared away, when the smooth and worn appearance of the limestone at once attracts attention. The bed immediately overlying the limestone, and which replaces it over a portion of the island, is a brown mud-clay, with a certain admixture of pumice and scoriaceous material, containing here and there small grits of sandstone. This deposit follows the contour of the hills, and has no sign of stratification. It thickens out very much in places, where it appears to possess more of the characteristics of true clay, and is so used on the south side of the hills, where brick-making is largely carried on. There is no trace of animal life and but little of vegetable life in the bed, a single specimen of raupo (*Typha angustifolia*) being the only plant I have discovered. A careful inspection of the material, however, leads me to the opinion that the mud-clay has been

burrowed by worms at a time when the material was perhaps covered with water. In several places the deposit has a kind of scale or slickenside formed over its surface, and when subjected to water-action for any length of time the clay has a tendency to swell and break away suddenly from the surrounding material. Over the Napier hills this brown mud-clay is not associated with any shingle deposits, but this is not the case in most of the other places where this clay is to be found. In the clays exposed between Sturm's Gully and the bluff overlooking the breakwater specimens of grit mixed with loessic mud are to be met with, whilst in the surrounding district extending from Tangoio to Puketapu the loessic clays are associated with shingle deposits in such a way as to suggest that the clays have been mainly derived from the shingle by the percolation of water. I have purposely directed attention to the smooth, worn, and rounded surfaces of the limestones, and to the characteristics of the loessic clays which either replace or overlie them, as they form the text upon which the following remarks are based.

Those who are acquainted with the topography of Hawke's Bay, or have read, with the aid of a reference-map, my description of the shingle deposits in this district, are aware how widely distributed these deposits are. It is a curious circumstance that the shingle deposits, so far as my acquaintance with the North Island is concerned, do not reach in a northerly direction to the 38th parallel of south latitude, and it is certain that the origin of the shingle must not be sought for to the north of that parallel. Shingle deposits are found in abundance farther to the south of that parallel, and they appear to reach their greatest development in the South Island eastward of the Southern Alps, the celebrated plain of Canterbury being made up almost entirely of such deposits. Years ago, when British and other geologists in the Northern Hemisphere were striving to interpret the life-history of the Pleistocene period by supposing the appearance of alternate cold and warm climates within certain limits of the north temperate zone, the ice or glacial theory took strong hold upon the leading geologists of New Zealand, and a number of papers appeared in the Transactions affirming the once large extension of the glaciers in the South Island, and pointing out that the Canterbury Plains are the outcome of a Glacial period, the formation "in their upper portion being morainic and in their middle and lower portion of fluviatile accumulations," the material for the latter being brought from the area within the glaciated districts. The late Sir Julius von Haast, in his "Geology of Canterbury and Westland," estimates that during the Glacial period the snow-line was 1,000ft. lower than it is in New Zealand at the present time. This estimate

is a very small one, representing, as it does, only a difference of about 3 degrees of temperature; and this certainly would not be sufficient to bring about a glacial climate in the South Island. Those wishing to read an interesting summary of the views of writers on a supposed Glacial period in the South Island are referred to vols. iv., v., vi., and vii. of the Transactions. In the latter volume Mr. W. Travers reviews the opinions of Sir Julius von Haast on the "Supposed Pleistocene Glaciation of New Zealand," and, whilst believing that a Glacial period has taken place in the country, does not consider there was any more glaciation than ordinary during the Pleistocene period, and believes that the Glacial epoch of New Zealand took place during the Miocene period, soon after the elevation of the present mountains, which at that time stood some 4,000ft. higher than they do now. I cannot find from the Transactions that any paper has been written suggesting that a Glacial period took place in the North Island at the same time as the supposed one did in the South Island, although it might be assumed that any causes which produced, or tended to produce, a colder climate in the South Island beyond what is warranted by a difference in latitude and elevation must have affected, though in a less degree, the climate of the North Island.

Before inquiring as to whether this Island, and, in particular, whether Hawke's Bay, has been subjected to glacial action it may be well to inquire what remains there are in a country which are considered as evidences of a Glacial period. We are sure that this district has been affected time after time by the volcanic outbursts that have taken place in the interior of the Island, by the fact that volcanic products are to be met with over the entire country, and distributed in such a manner as to leave no doubt as to the way those products came to occupy their present position. And the same thing must be done in pursuing the inquiry as to whether a glacial epoch has ever occurred in this district. In England and other countries that are said to have passed through more than one glacial epoch the evidence for such is said to be found,—

1. In the distribution of moraines and drifts—the direct products of glaciers;

2. In the presence of lakes or tarns in mountainous districts;

3. In the finding of erratics or isolated rocks in places where no similar rocks are to be found, such as granites or conglomerates;

4. In the peculiar shapes of the hills or bosses where glaciers have existed;

5. In the scratchings or markings upon the hard rocks in places once covered by glaciers.

Evidence of this kind is considered to be conclusive of the former presence of glaciers in a district or country. The whole of such evidence may not be available, but this would not lessen the value of the facts in cases where it is satisfactorily established that moraines have existed, as moraines are the special products of glaciers.

The greater part of what was formerly the Provincial District of Hawke's Bay is connected with what is essentially an area of shingle deposition. The distribution of shingle and other allied deposits, including sands, pumice, clays, lignite, and a conglomerate, extends to the southward, and is equally diffused on the western slopes of the Ruahine Range. This shingle deposit is to be found even more widely diffused along the eastern side of the South Island, and there are many important reasons for supposing that in the earlier part of the Pleistocene period the area now known as Cook Strait was a land-area. On both sides of the strait the valleys are made up of Pleistocene deposits of shingle, and they almost suggest the possibility of all the valleys along the east side of both Islands having been at some portion of the period connected with an immersed area farther to the eastward of the present coast-line, the entire drainage from the watershed trending to the south-east.

We have seen that it has been stated by the late Sir Julius von Haast that the Canterbury Plains "have been formed in their upper portion by morainic and in their middle and lower by fluviatile accumulations." Whether the same thing has taken place in connection with the shingle deposits of this district is a question which is yet unsettled. Before proceeding to discuss the merits of the evidence available in favour of a Glacial period in the North Island it may be well to give a brief survey of the distribution of shingle and cognate deposits in the district more immediately connected with the water system of Hawke's Bay. This is the more necessary because at the present time there are two separate and distinct shingle-areas in the district, the one being the areas known as the Ahuriri and Ruataniwha Plains, the other certain areas which will be now described. The former areas are situated between the latter, and, in fact, they overlie some of the latter deposits which remained after a period of submergence that took place between the close of the one formation and the opening of the more recent one. The coast-line of Hawke's Bay, extending from Cape Kidnappers in the south to Te Mahia in the north, consists mainly of high cliffs, rising in places more than 400ft. above the sea. The only low coast is that which bounds the Ahuriri Plain, and extends from Tangoio to near the Kidnappers. At the mouth of the Wairoa River the cliffs are somewhat lower than to the immediate north or south; and

near the south entrance there is a large exposure of shingle conglomerate, which has hitherto withstood the force of the heavy breakers that constantly roll in from the open ocean.

These conglomerates are found topping the hills to the right of the road between Wairoa and Te Kapu, and they strike across in the direction of the cemetery on the hills at the back of the Wairoa Township. I have seen no shingle between this p ace and Mohaka, but at the mouth of the latter river heavy conglomerates rest immediately on Miocene beds, at a height varying from 80ft. to 150ft. above sea-level. Traces of these conglomerates are to be found along the coast for several miles to the south, in the direction of the Waikare River, always topping the Miocene beds, and being situated in what appears to be an old valley leading to Lake Tutira, where, on the highest hills to the north of this lake, I lately saw shingle conglomerates and sands corresponding to the Pohui series. Large loose boulders were also seen, similar to those topping the Miocene beds on the sea-cliffs between Mohaka and Waikare. Isolated deposits of shingle are met with on the hills in the vicinity of Tangoio, and at Maraetara near Petane, at Redcliffe near Taradale, and on all the islands between Tangoio and Napier shingle deposits, with clays, &c., are exposed. Finally, all the hills extending from Havelock to the Black Reef, inside the Kidnappers, are made up of shingle sands and cognate deposits. I have already explained that the Pohui conglomerates are met with to the north of Lake Tutira. This, I believe, is the most northerly point reached by these beds. With respect to the shingle deposits that are exposed to the south of Tangoio, they are connected directly with more extensive deposits farther to the westward by means of the rivers draining into Hawke's Bay in the south: for example, the Esk or Petane River passes wholly through shingle and conglomerate deposits which are connected directly with the great conglomerate series in the Pohui district.

And the same remark applies equally well in the case of the Tutaekuri, Ngaruroro, and Tukituki Rivers in their upper and middle course. The area forming the Ahuriri Plain, across which these rivers pass in their lower course, is not connected with the deposits under notice. The former is much younger than the latter, and is the result of subsidence and refilling from some of the material of the older deposits mixed with new material from the upper waters of the rivers above named. All the shingle deposits through which the Esk, Tutaekuri, Ngaruroro, and Tukituki flow are at a much higher level than the rivers themselves, and they are often mixed with clays, sands, lignites, and other materials, as if they had once occupied lake- or swamp-areas. It is important to observe that the shingle and cognate deposits do not pass from one

river-basin to another : that is, the area which really constitutes the water-parting between any two river-basins shows no traces of shingle deposition. In other words, there is no evidence that the shingle, which is well exposed in many places through the course of each river, merged in the several river-basins and covered the country from the westward to the place where the rivers emptied themselves into the sea or inland lake, as the case might be. Though no merging of the shingle deposits took place, either in the middle or lower course of the rivers named, it is found that these deposits are all connected with an extensive area of country flanking the Mangaharaaru, Titiokura, Kaweka, and Ruahine Ranges. This area is made up of grits, shingle, conglomerate clay, and lignite, and it extends in one continuous line, from north-east to south-west, for a distance of more than 120 miles. The whole of the country extending from Pohui, on the Taupo Road, through the Ruataniwha Plain to Woodville, is composed mainly of those beds. Traces of limestone are to be seen here and there, but generally the limestone has been displaced by the conglomerate and cognate beds in the whole of this area. In the shingle deposits no boulders of any large size are found, nor are there traces of erratics of a material different from the general characteristics of the rocks composing the conglomerates and shingle. Along the slopes of the ranges between Kereru and Pohui there are a few traces of larger and coarser material than is usually associated with the conglomerates, and farther to the south these deposits become most marked, as they form long transverse ridges, running almost at right angles to the direction of the Ruahine mountain-chain. The boulders composing these ridges are subangular, and are mixed with a friable clay, and are seen to overlie the older conglomerates, and, indeed, are unconformable to them. The greater portion of the Ruataniwha Plain appears to be made up of these beds, which, though younger than the conglomerates, are older than the present river-deposits, being evidently connected with the rivers when they flowed at a higher level and in much larger volume. These transition beds are Ruahine products, and they may be traced as offshoots from the mountains throughout their whole extent, but more particularly between Hampden and Woodville. The underlying conglomerates flank the mountains and dip at a high and uneven angle wherever exposed. On the western side of the mountains similar beds are met with, and they dip at an angle which suggests great changes since the time of deposition.

I have now given the distribution of the conglomerates, and what may, perhaps, be classed as drift deposits in this district. It will have been noticed that their main distribu-

tion is in a north-east and south-west direction, in what was apparently an immense valley which communicated with the sea on the east by several transverse valleys, which subsequently became the valleys through which the rivers from the western watershed pursue their course to the ocean.

The question next arises as to what occupied the area previous to the deposition of the conglomerates. I have already explained that generally where the shingle and conglomerates are absent limestone is present—limestone belonging to the same geological period as the Napier limestone. Where there are no clays in Napier the limestones are present, but where the clays are well developed the limestones are either absent, or their rounded surfaces and bouldery appearance testify to great denudation. Now, this rule holds good over the whole of the district, except that the shingle and conglomerates occupy the place of the loessic clays. Previous to the deposition of the conglomerates the whole of the area between the east coast and the present volcanic belt of which Tongariro is the centre was covered with young Tertiary limestone belonging to the Pliocene period. This is proved by the fact that on the top of the Ruahine Mountains outliers of this limestone are found opposite the Kereru, and the range immediately to the east of the Kaweka Mountains is also made up of limestone, whilst similar limestone is to be seen farther to the west at a height of 4,500ft. above sea-level on the south end of the Kaimanawa Mountains.

Now, all the Pliocene deposits with which I am acquainted in this district are of marine origin, and it must be evident that great changes have taken place in the surface of the country since these deposits were formed. Either there must have been elevation to the extent of 4,000ft. or more, or there has been a lowering of the ocean to this extent. In any case the fact remains that to-day there is a difference in elevation of similar deposits in this district of more than 4,000ft., and, as they are all marine deposits, it may be supposed there has been elevation to this extent since the close of the Pliocene period. At the close of this period there were no mountains like the Ruahine and Kaweka Ranges, for the whole country to the south and east of Ruapehu appears to have been covered with limestone, and for some time after the elevation of the Pliocene beds had begun it would seem that the drainage from the volcanic centre was mainly to the north, east, and south.

At the present time the watershed of Hawke's Bay may be said to be limited by the Ruahine and Kaweka Ranges; but it is certain from the products such as are exposed for 300ft. or more at the Kidnappers that the watershed when these deposits took place was in the direction of the volcanic centre. Even before the mountains began to take definite

shape it would seem that a large portion of the limestones had been denuded, and their place occupied by deposits made up sometimes of pumice and shingle, and sometimes, with pumice, shingle and lignites or clays. All these beds are largely developed in the vicinity of the Ruahine and Kaweka Mountains, and they are found covering the country, at an elevation of 2,000ft. or more, down to sea-level. The elevation of the Ruahine and other associated ranges produced important changes in the physical features of this district. From the appearance of the Pleistocene deposits, which certainly had been completed before the elevation of these mountains, it would appear that the places where the deposition took place were large trough-like areas, which acted as catchments for the material brought down from the volcanic district. At that time the whole of what is now sea, extending from the Kidnappers to Te Mahia, was partly covered with limestone and partly with shingle and pumice-beds of the Kidnappers type.

This large area which had been elevated during the Pliocene period, and had been partly denuded and covered by newer deposits, was again submerged during the elevation of the Ruahine Ranges. At the same time, what is now the Ruataniwha Plain was depressed several hundreds of feet, the elevation of the one area being in a measure balanced by the depressions within the areas named. It is not possible to say whether the Ruahine, Kaweka, and associated mountains were raised to a much greater height than they now are. Judging by the material distributed over this district, and which has come from these ranges, it would seem that the height has not been much greater than at present. Denudation has undoubtedly been very great in those mountains, as the filling-up of the Ruataniwha and other areas amply testifies; but there is little evidence on the mountains themselves to show that they have been subjected to ice-action, or that glaciers have had possession for any length of time.

I have already quoted Sir Julius von Haast on the probable lowering of the snow-line by 1,000ft. by some cause not readily apparent. But, if we assume that the Ruahine and Kaweka Mountains were under similar conditions, and that the snow-line was lowered for this Island by 1,000ft., it would then be impossible under present physical conditions for glaciers to exist on those mountains. In the latitude of Napier the snow-line is about 8,000ft. above sea-level, this being the height of the snow-line on Ruapehu. The highest peaks of the Ruahine reach a little above 6,000ft., and there is one peak on the Kaweka within a few feet of 6,000ft.; so that if we assume the same conditions to have existed in the North Island as in the South during the latter part of the Pleistocene

period there was no portion of the mountains covered with perpetual snow. It may have been that the physical conditions, as regards climate and winds, were unlike what they now are, and that in the latitude of 39° or 40° S. glaciers existed at a much lower elevation. We know that in the Southern Alps the Franz-Josef Glacier, on the west side of Mount Cook, comes to within 700ft. of sea-level; whilst the Tasman Glacier, from the same mountain but on the eastern side, has its terminal face at an elevation of 2,350ft. above the sea. These glaciers are situated in a latitude corresponding to the south of France and north of Italy, in Europe; and, if physical conditions can exist in a warm temperate area like New Zealand so that important glaciers can descend to within a few hundred feet of sea-level, and be surrounded at the same time by arborescent ferns and a luxuriant vegetation such as are reported to exist in the vicinity of the Franz-Josef Glacier, it may have been quite possible for glaciers to have existed on the Ruahine and Kaweka Mountains, whilst at the same time a warm temperate flora such as now prevails flourished on the mountain-side and in the warmer valleys below.

On the top of the Kaweka Range there is a mountain-tarn, and many large boulders are lying about. Farther to the south there are peculiar terrace-like walls, and there are also traces of what I suppose are moraines, made up of subangular stones lying in parallel bands, and arranged in as regular a way as if put down by human hands. On the Ruahine also there are several large areas covered with blocks of sandstone, and there are tarns and deposits similar to those on the Kaweka. Assuming that these regularly-arranged rocks are terminal moraines, they only serve to show that small accumulations of ice have existed on the mountains, but that the ice did not descend lower than 4,500ft. from sea-level. But a difficulty presents itself on the supposition that no glaciers other than small and unimportant ones have existed in the western mountains. I have referred to deposits coming from the Ruahine and overlying the older Pleistocene deposits on the western side of the Ruataniwha Plain, and, in fact, extending from Hampden to Woodville. These deposits consist of long ridges of rough semiangular shingle and boulders, mixed with clay and loose soils, running almost at right angles to the mountains, and terminating on the plains in high faces or bluffs from 20ft. to 50ft. in height, with a somewhat steep and even overhanging slope. These ridges run for miles back towards the mountains, widening as they go, and all of them subsequently merge where the slope is suddenly terminated by a deep longitudinal valley which intervenes between the ridges and the foot of the mountains. Two years ago in August I stood on the margin of this valley, which was then

white with snow, and the question came to my mind how this deep valley had been scooped out, as the scooping had evidently taken place since the formation of the ridges. Was it by means of water or ice, or was the valley simply a great rift that had been made by the elevation of the mountains? The evidence in favour of ice- and water-action seemed to me the more probable, and this opinion has been strengthened lately by reading the account given by Wright, in "Man and the Glacial Period," page 30, on the formation of what are known as "kames," or ridges. He says, "I have witnessed the formation of a long ridge of gravel by the gradual falling-in of the roof of a tunnel which had been occupied by a subglacial stream, and over which there was deposited a great amount of morainic matter. As the roof gave way this was constantly falling to the bottom, where, being exempt from further erosive agencies, it must remain as a gravel-ridge or kame."

The extreme length of the ridges to the west of the Ruataniwha makes it improbable that they were formed solely by the action of ice; but the products and the arrangement of the material are such as to suggest drift accumulations where water has played an important part. For years I have endeavoured to find out how such striking landmarks as those to be seen near Hampden and Te Ongaonga, on the Ruataniwha Plain, could be formed, and during the flood in this district in December last year I noticed on the beach at Waitangi, near Farndon, that ridges had been made by the waves of the sea washing over the beach and carrying shingle into a backwater area connected with the Ngaruroro River. These ridges had faces and an outline corresponding in every way with those described as facing the Ruataniwha Plain on its western margin. Geikie, in his Geology, page 892, mentions kames, but is doubtful as to the way they are formed. There is one other place near the mountains that requires notice. Between the Kaweka Range and a lower line of hills farther to the east, and known as Blowhard, there is a deep and somewhat wide valley of sterile country composed of a kind of brown tufaceous clay containing here and there peculiar patches of subangular pumice pebbles. Interbedded with this deposit are very large boulders and rough stones of all sizes and shapes. The valley is parallel with the Kaweka Range, but does not now receive the drainage from it. The country is much broken, and the limestones which top the hills at Blowhard, both when *in situ* and when lying about in large blocks, contain flutings and ridges, the origin of which it is hard to interpret. There are several lakes within the area named, and the coarse accumulations of shingle, &c., in the vicinity may represent the products of glaciers. But glaciers can only exist in temperate climes under special conditions as to eleva-

tion, moisture, protection from warm winds, and a suitable basin of accumulation of *névé* or *firn* to provide a supply for the glacier, and these conditions are certainly not possible at the present time either on the Kaweka or the Ruahine Mountains.

Nor do the immense deposits which represent the Pleistocene older period, such as are scattered over the district outside the area just described, supply satisfactory evidence in favour of an extended glacial cap on the mountains and reaching to the plains below The pumice deposits in many places are more than 100ft. in thickness, and the shingle, though not composed of material derived from lava or other volcanic products, contains many specimens of trachyte; and, judging by what was thrown from the several craters during the eruption at Tarawera in 1886, it is quite possible that all or most of the shingle which is interbedded with the pumice was thrown from a volcanic orifice. Whether this was the case or not, we are forced to recognize that the time when the deposits took place was one of great volcanic activity, and when most of the country was covered with volcanic ejectamenta. The blue clays, with many pumice pebbles scattered through them, and containing an abundance of marine shells, show that differential earth-movements were in progress whilst the Lower Pleistocene beds were being deposited. These blue clays are succeeded by pumiceous sands and lignites at the Kidnappers, and by fine pumiceous mud-clay at Poverty Bay, which are crowded with leaves of every variety and size. In the Patangata beds, the *Unio* and other fresh-water shells are found in abundance in the lignite beds; and at Ormond and Gisborne, in the Poverty Bay district, specimens of a small fish like the inanga, so common in the underground streams flowing from Tongariro into Lake Rotoaira, are common, as also a *Unio* and other shell-fish. In the same beds feather impressions have also been obtained. These beds, in which so many traces of animal and vegetable life are found, show that the land was probably rising at the time of their deposition, and they further show that the country, in part at least, was covered with a varied vegetation, possessing all the characteristics of the present flora.

I do not profess to be able to distinguish the different kinds of trees which characterized the Lower Pleistocene period simply from the leaf-impressions in my possession, but there can be no doubt they illustrate the flora not of a locality, but of a large district in both vertical and horizontal space. And this leads me to one of those aspects in connection with so-called glacial phenomena that have always appeared to me to receive too scant attention at the hands of the glacialists. Because plants indicating a cold

climate are found associated with those of a warmer climate it has been generally assumed that a colder climate prevailed, whilst the contrary must have been the case. Every basin of accumulation must be considered in its flora and fauna as representing a horizontal and a vertical area. Take, for example, the deposits now going on in Hawke's Bay from the Rivers Ngaruroro and Tukituki. These rivers carry down to the sea the material from the whole of their drainage-basins. Leaves from the slopes of the Ruahine and Kaweka Ranges will be mixed with plants from the warmer hill-slopes bounding the Heretaunga Plain, just as the shingle and finer rock-material from the one area will be mixed with the coarser material from a different area at the spot where deposition is most favourable. Now, when the deposits underneath the Bay come to be raised, as they very probably will, the leaves which have left their impressions on the finer sediment will illustrate first a warm temperate climate, and second a climate no less than 20 degrees lower than what we now enjoy in Napier. But the verdict of the glacialists as read by their interpretation of fossil life to-day would be that cold summers and mild winters formerly prevailed in this district. Thus Professor James Geikie, in his "Fragments of Earth-lore," p. 265, says that "during one period of Pleistocene clement winters and cool summers permitted the wide diffusion and intimate association of plants which have now a very different range. Temperate and northern species, like the ash, the poplar, the sycamore, the fig-tree, the judas-tree, &c., overspread all the low grounds of France as far north at least as Paris."

But surely this is not dealing with the subject of the geographical distribution of plants on lines which the study of physical geography points out as necessary if we are to arrive at a proper estimate of the work done by rivers in the matter of erosion and reconstruction. My illustration might be carried to an inland sea—the Mediterranean, where rivers such as the Rhone and the Po from glacial areas and the Nile from a tropical area pour their burdened waters into the same basin of accumulation. By means of currents and gravity the material from the different rivers will tend in the direction of the deepest portion of the basin, and the floral representatives from Europe and Africa will eventually merge or form parts of the same continuous area of deposition. Thus the same statement might be made with respect to the plant-impressions from these areas as is now made with regard to the Pleistocene period—that clement winters and cool summers permitted the growth of tropical, temperate, and arctic plants within the same area. Surely the fossil leaves and plants, specimens of which are open for the inspection

of members, from the Pleistocene deposits of this district do not tell us anything more as to the kind of climate which prevailed at the time of their deposition further than to limit the bounds of temperature within the basin of accumulation both in vertical and horizontal space. And there can be little doubt, it seems to me, judging by the character of the leaf-impressions so widely scattered among the deposits of the district, that a fairly warm climate prevailed in the lowlands during the Pleistocene period not unlike that now experienced along the east coast of this Island, whilst in the uplands the contrasts of heat and cold were no wider than they now are between Napier and the volcanic zone.

But, assuming that the Pleistocene deposits described by me as being so widely diffused over this district afford evidence of glacial action, I do not see that even then the climate that prevailed was necessarily cooler than what it now is in the lowlands. It has already been pointed out that glaciers reach within 700ft. of sea-level in the South Island under special conditions. This represents an elevation of about 1,600ft. for Hawke's Bay; but climate depends upon many modifying influences other than latitude and elevation, and, if these are present, as in the case of the Franz-Josef Glacier, there appears no reason why glaciers could not exist in the Ruahine and Kaweka Mountains, even though the climate of the district is represented by a warm temperate flora.

In England, Europe, and America the Glacial period is recognized to have taken place during the same period as characterizes our pumice, shingle, and conglomerate deposits. It is supposed, however, that during the Pleistocene period a succession of warm and cold epochs took place in such a way that a warm epoch was succeeded by a cold one, and that this alternation from warm to cold continued until the close of the period. Geikie, in "Fragments of Earth-lore," page 319, enumerates five such glacial and five interglacial epochs as having occurred in Europe. The conclusion is based upon the fossil flora and fauna that have been found in the deposits which are referred to this period, and he says that the "cold conditions that culminated in the Glacial period began to manifest themselves in Pliocene times"; whilst Heer, in his "Primeval World of Switzerland," remarks that "from the Miocene to the beginning of the Quaternary period, during a comparatively short time, a complete alteration took place, and the temperature of the Glacial period sank below the present level." It is fully recognized that, so far as Europe and North America are concerned, the Pleistocene deposits are such as to show great alternations of level in the surface of

the land, with corresponding changes in the fauna and flora, and that the climatic contrasts during the period were very marked.

It is necessary, however, to guard against too hasty conclusions on this important question of climate, for in the "Quarterly Journal of the Geological Society," No. 198, and published in May last, Mr. E. J. Newton, F.R.S., in an important paper which he communicates to the society, says: "Much interest attaches to a correct knowledge of the climate prevalent during the Pleistocene period, indications of which are to be found in the arctic fresh-water bed of Norfolk, the boulder-clay, and the animals which are found in the various deposits. The probability of alternations of warm and colder periods during Pleistocene times has long been advocated; but it has been thought possible by some that, with a more continental climate than at present prevails in Britain, the alternation of summer and winter might be sufficient to account for the seeming mixture of species. Whatever may be the cause, the Pleistocene fauna as found in the brick-earth, gravel, and cave deposits seems to be of a mixed nature, the species finding their nearest allies at the present day living under widely diverse climatic conditions. Some of the Pleistocene species thus indicate extreme cold, others point to distinctly steppe conditions, while a third seems just as strongly to prove the prevalence of a warm climate. These difficulties will doubtless eventually be removed, but in the meantime too much stress must not be placed upon the range of Recent animals as an indication of the past, seeing that there are many circumstances besides climate which help to determine the distribution of species."

This quotation shows that the inferences drawn from finding an intermixture of animals representing warm, temperate, and cold regions of the earth must be accepted with caution until we are better acquainted with the climatic conditions that prevailed during the Pleistocene times. But the many changes and the contrasts which characterized the Pleistocene period of Europe and America do not appear to have taken place in New Zealand during the period recognized as Pleistocene. As remarked by Professor Hutton in vol. viii. of the Transactions, p. 386, "The evidence is against the idea that a colder climate formerly obtained in New Zealand." This statement is founded on the character of the fossil shells found in certain Pleistocene beds examined by him, and he arrives at the conclusion that "since the Miocene period there can have been no reduction of temperature sufficient to account for the former extension of our glaciers." This conclusion supports my own, which is based upon evidence derived from entirely different sources. As pointed out above, the fossil leaves which are

scattered through the lignite and pumice beds of the Lower Pleistocene period do not support the view that the climate differed in any material point from what we have at the present time, as represented by plain and mountain. It may perhaps be urged against this that the deposits containing the fossil leaves represent an interglacial period, and that the shingle and conglomerates above and below the leaf-beds represent two or more Glacial periods. But this is impossible, for the reason that all the beds belonging to the Lower Pleistocene deposits are strictly conformable to one another, and it would be manifestly impossible for such to be the case had the beds been laid down in different epochs. To me it is quite evident that the shingle was carried down in a manner similar to the pumice, and probably from the same source, but in what way the deposition took place—whether into a lake or estuary, or into a series of depressions which afterwards became part of a river-bed—I cannot say. During the deposition of the lower beds of the Pleistocene period—that is, during the time which followed the elevation of the Pliocene limestones until the elevation of the Ruahine and Kaweka Ranges—the climatic conditions prevailing in the North Island seem to have undergone little or no change. The conformity of the beds shows this to be so, and the fossil flora and fauna testify to the fact. If glaciers of any size ever existed on these mountains the products are to be found on the Ruataniwha Plain, in the valley between Blowhard and the Kaweka Range, and in the kames, which have been described as forming such a characteristic feature along the western margin of the Ruataniwha. The evidence here is much stronger than on the mountains themselves of the former existence of glaciers, and it is also stronger than that supplied by the distribution of the so-called loessic clays, the high-level shingle deposits, or the rounded and worn limestones on the Napier and adjacent hills. There, if anywhere in the district, is evidence forthcoming of morainic accumulations of drifts and of glacial products generally. But unless the elevation of the mountains was much greater than at present, which seems very unlikely, some other cause must be found to account for their existence should it be found that glaciers have occupied the mountains and valleys along the western part of this district.

In any case it appears that the reason urged for the existence of a Glacial period in the South Island by Haast, Hutton, and Travers — namely, a great elevation of the land — can hardly apply to this Island, as there is nothing whatever to show that the mountains were ever higher than they now are. Evidence of elevation and depression since the close of the Pliocene period is to be met with everywhere, but the eleva-

tion has been insufficient without the operation of other causes to bring about an ice period, nor have the depressions had any apparent effect upon the flora and fauna. In Europe we are told the depression of the land "preceded and accompanied the appearance of the ice-sheets," and, what is stranger still, "the submergence had a remarkable relation to the extent of glaciation." It will be noticed how unlike the periods known as Pleistocene were in the Northern and Southern Hemispheres, as judged by the facts at present collected. In the north the period was one mainly of depression; in the south we are told it was one of elevation. In the north the surface-changes are said to have been frequent, depression and re-elevation following at regular intervals; whilst in the south few changes took place, and the physical conditions remained almost constant. It is difficult to account for such diverse interpretations of a period which has so many things in common in both hemispheres, and it may be that the time will come when a more perfect knowledge of the physical conditions that prevailed on the earth during the Pleistocene period will enable glacialists to harmonize what now presents so many contradictions, and to simplify phenomena which are too often interpreted so as to fit in with some theory or other that has received the approval of geologists simply as a working theory and nothing more.

Part II.

In striving to harmonize what appears so contradictory as to the sequence of events connected with the Pleistocene period in the Northern and Southern Hemispheres, it may be well to refer to certain recognized facts connected with the sun and the earth in relation to the other portions of the solar system. From the sun the earth receives its heat, which reaches the surface through the medium of the atmosphere. Of every 100 units of heat that comes within reach of the aerial ocean Alexander Woeikof says that only about 60 per cent. reaches the earth's surface at the equator, 55 per cent. at 20° north and south, 41 per cent. at 40°, 24 per cent. at 60°, and only about 10 per cent. at the poles. Hence much more than half of the amount of heat which comes within the limits of the earth's envelope passes back into space without doing any effective work whatever on the surface of the earth. Now, there is nothing that we know of in nature which can give off any portion of heat for an indefinite length of time without lowering or diminishing its own effectiveness. A ton of coals has so much available energy and no more: and so with respect to the energy of the sun. He cannot go on for ever sending his heat and light to our own and other worlds without loss of

energy, for the sun, like everything else of which we are cognisant, must have had a beginning, and he will also have an end. If such is the case, it follows that the supply of heat which the sun has given and is giving off is a varying quantity, diminishing slowly and surely as periods roll on. It may be assumed, therefore, that much more heat was given off from the sun during the Pleistocene period than is given off now; hence more heat must have reached the earth in each zone than is the case at the present time. It follows also that, so far as the heat from the sun affects the earth, the latter was, on the average, warmer in Pleistocene times than in Recent.

Now, the question of temperature is one of great importance in connection with all aqueous and aerial movements. If the sun is the source of a varying supply of heat, it is certain that the earth, if the nebular theory is assumed, is also parting with a varying quantity of heat. This earth cannot possibly remain at the same temperature for an indefinite period of time, for, without considering the amount of heat supplied by the sun, it follows from the law of exchanges that this earth is parting with some of its own heat into outer space. It is true the amount is small, being only $\frac{1}{3\,6}$th of a degree per annum, but continued for a long period of time the quantity becomes of high importance. From the equator, as we proceed either in vertical or horizontal space, the cold increases at a progressive rate, so that on the equator at an elevation of 15,000ft., or in round numbers, say, three miles, a place is reached which is always below the temperature of frozen water; and the same may be said with respect to temperature beyond the arctic and antarctic circles, in the direction of the poles. This condition of things could not always have been so: in fact, the temperature of the earth at one period of its history was such that unless the mountains were much higher than they now are no snow could have remained upon them, even towards the poles, and frost and hail must have been unknown. At that time the temperature of the atmosphere must have been such that much more aqueous vapour was held in suspension than is now possible, as the quantity of vapour is limited by the temperature of the air. Thus at the present time a cubic foot of dry air weighs about $1\frac{1}{4}$oz.; and this at a temperature of 60° Fahr. will absorb about $5\frac{1}{2}$gr. of vapour, and no more. At a temperature of 80° Fahr. the same quantity of air will absorb about 11gr. of vapour, and so on according to the degree of temperature of the atmosphere, it being found that in order to saturate a given space like a cubic foot the vapour required increases as the temperature increases. If, as is now recognized by most geologists, the earth has reached its present condition by a slow process of cooling, it follows that the

temperature of the earth itself, irrespective of the heat received from the sun, was greater than it now is, and with the additional solar heat it is certain that greater contrasts of heat and cold must have prevailed on the earth's surface and its attendant atmospheric envelope.

But if we assume that during the Pleistocene period the earth was warmer, that evaporation was possibly greater, and the movements of the atmosphere and the waters of the ocean were more pronounced than they now are, it is of the highest importance to understand the effect of increased evaporation as a diffuser of heat over the earth's surface. For example, a pound of water at boiling-point absorbs during its evaporation as much heat as would raise 5½lb. of water from freezing-point to boiling-point, and this without increasing the temperature of the vapour. If we consider the vast quantity of evaporation that takes place in the warmer zonal regions of the earth, it must be evident that an enormous amount of energy is expended in this constant conversion of water into vapour, and that large quantities of heat are transferred in this way from the warm to the colder zonal regions. As pointed out by Balfour Stewart, "Our own earth is . . . an engine having the equatorial regions as its boiler and the polar regions as its condensers, for at the equator the air is heated by the direct rays of the sun, and we have there an ascending current of air, up a chimney as it were, the place of which is supplied by an indraught of colder air along the ground or floor of the world from the poles on both sides. . . . Very often, too, aqueous vapour as well as air is carried up by means of the sun's heat to the upper and colder regions, and there deposited, in the shape of rain or hail or snow, which ultimately finds its way back again to the earth, often displaying in its passage immense mechanical energy." But what becomes of the heat—the latent heat which was absorbed when the water was passing into vapour? That it does not return to the earth is evident, for the rain or snow or hail, as the case may be, is much below the temperature of the vapour from which it was derived by condensation.

In this process of carriage and condensation a large quantity of heat becomes dissipated, and is finally lost by passing away into outer space. Thus, although great stores of heat are carried from the warmer to colder regions of the earth by atmospheric agencies, in the performance of this work much extra heat is demanded, and it is by the expenditure or partial loss of this heat that the work of condensation is carried on. The nearer the product of condensation is to the freezing-point the greater the quantity of heat left behind, and subsequently diffused in space. Thence it follows that the

wider the temperature contrasts between any two zonal regions the greater must be the quantity of heat which passes between them. But although the earth was warmer and the sun gave out more heat to the earth in Pleistocene times, it does not necessarily follow that the climate of Europe, America, and Australasia was warmer than now. Climate is the average state of the weather in any district or country based on a long period of observations, but the causes which regulate the weather are by no means well understood, as the people of Hawke's Bay have been made fully aware during the past twelve months. The great modifiers of climate are latitude and elevation; but there are other modifiers, which, though second to those named, have yet an important influence on the climate of a country. At the present time Europe maintains but few glaciers except in the Alps and northern Scandinavia, and none are met with in any portion of the British Isles. During the Glacial period nearly the whole of western Europe is said to have been covered with ice, and, as already pointed out, the period is said to have been one mainly of submergence. None of the Alpine glaciers now descend below the level of 4,000ft.; there are no glaciers in North America of large size or descending below the 4,000ft. level; so that it may be supposed the climate of Europe in Pleistocene times was from 10° to 15° below the average temperature of that continent at the present time.

Considering the latitude of the area in which glaciation is said to have taken place, it seems that some causes which do not now exist must have operated to produce such unusual climatic contrasts as are said to have characterized the Pleistocene period of Europe and America. The difficulty which presents itself here is not so much in the wide extension of the glaciers as in the vast amount of condensation that must have taken place beyond the snow-line, in order to provide a *névé* or *firn* for the supply of the glaciers. For a glacier is simply an ice river below snow-line with its source above snow-line, and the very fact that glaciers exist is evidence in itself that below the snow-line the temperature is more than sufficient to melt the ice were the supply from the *névé* not so great. The movement of the Franz-Josef Glacier in New Zealand to within 700ft. of the sea-level, and far below the limit of perpetual snow, shows that such a thing is possible. But a glacier of this kind is clearly dependent on some special cause. It is not possible to conceive of a glacier unless on the assumption of a source of supply in a region where water is never found other than in one of its crystallized forms. The "snow-line" implies that everywhere above that line the temperature of the air is such that condensation produces either snow or hail. Cut off the supply or *névé* from the Franz-

Josef and Tasman Glaciers and they will disappear in a definite time, as estimated by the average annual temperature of the area they now occupy; and the same thing must have held good in Pleistocene times if we assume that the same physical conditions existed then as now. But Geikie says that the Pleistocene period was one of depression in Europe, although, so far as Switzerland is concerned, Heer appears to think that the Alps were somewhat higher than at present. In any case, if glaciers covered the areas they are said to have covered in Europe, America, and elsewhere, there must have been special areas for the accumulation of snow to supply those glaciers. Nor can we conceive of such areas being below the "snow-line," as it is at present understood. But was the snow-line higher or lower during Pleistocene times? This question is a difficult one to answer, because, if the temperature of the earth was warmer—which has been assumed—it follows that the "snow-line" would be, on the average, higher.

The question of climate, however, is one of much difficulty, as the distribution of the land, the height of mountains, the direction of winds, of currents, and of mountain-chains, all tend to modify and influence the temperature of a country. The Gulf Stream that washes the western shores of Europe causes countries like the British Isles, Denmark, and Norway to enjoy a temperature much higher than what is enjoyed by the people along the eastern shores of North America in similar latitudes, and whose shores are washed by the arctic return-current. It is estimated that not less than half the heat received from the sun within the torrid zone is carried by ocean-currents to the north and south, for diffusion among the colder waters of the ocean. But it is quite possible, and, indeed, very probable, that the land- and water-areas were differently arranged during Pleistocene times from what they now are. A cold current passing along western Europe would so modify the climate that glaciers would certainly increase in size, and the conditions of the countries named above would become greatly modified. Assuming that the glaciers have existed in Europe, America, and elsewhere during Pleistocene times, and assuming also that the facts as to elevation, depression, and temperature are such as have been stated, it seems hardly possible to harmonize the differences except on the supposition that some cause outside the earth itself was operating to bring about the conditions named.

Many theories have been offered to account for the incoming of a cold period and the return to a normal period of temperature over an important portion of the earth's surface. Heer says, in his "Primeval World," that "from the Car-

boniferous to the Cretaceous period no climatal changes can be proved to have taken place; whilst from the Miocene to the Pleistocene (Quaternary) period, during a comparatively short time, a complete alteration took place, and the temperature of the Glacial period sank below the present level." Such a statement, coming from so high an authority, should be received with due respect; but, if we accept the statement as covering the actual facts, it seems to me we shall be led into mazes which go rather to show that the earth in all its developments is rather the product of chance than of a definite law of progress. Was there no change during the thousand centuries that intervened from the Carboniferous to the Cretaceous period? Denudation proceeded, new life began and ceased to be, and yet we are told that there was no climatal change! It is not possible to prove by actual experiment that climatal change is constant and ever-active, but the law of change operates, and, as far as we know, has always operated, through everything in nature, and, if it is recognized that heat is passing, and has passed, from the sun and this earth since the time when the latter was a gaseous mass, it needs no proof to show that climatic changes, however small, must have gone on from the Carboniferous to the Cretaceous period, just as they have gone on since the Cretaceous till now. Had there been no climatic change, whence would have come the differentiations in the animal and vegetable kingdoms? With a warm earth, and a warmer sun than now, the earth contrasts in the early periods of life were less marked than now. Every moment since the earth began to be habitable for the support and maintenance of life, life contrasts have been increasing in the exact proportion to the increase in the differentiations and adaptations in the animal and vegetable worlds. As the heat diminished there were more places adapted to the existence of life, or, in other words, the activities for the maintenance of life increased and extended. This extension brought about adaptation, and so it has been that time, multiplied by climatic change, has produced what we have to-day as the total product of all geological change.

But do those changes proceed at a more rapid rate to-day than they did in the earlier periods of geological history? I think so. Movements are greater or more rapid between particles of the same substance in exact proportion to their contrasts in the matter of temperature. The mixture of two pints of water, one at 90° of temperature and the other at 92°, would be much slower than the mixture of the same quantity of water at 45° and 100° respectively. The law of exchange comes in here, and the movement in the latter would be more active because the contrasts are greater.

The same applies in the case of air, strong winds being the result of wide contrasts of temperature combined with the tendency which is found everywhere to make everything of the same mean or average heat. In the earlier periods of the earth there was a greater closeness of temperature in the waters of the ocean than there now is, just as there was in the temperature of the air. There could be no sea or ocean until the temperature had fallen below that of boiling water, and when condensation began the water contrasts were small, and whatever animal and vegetable life existed was limited by the closeness of its contrasts. This was at the beginning of life in this earth of ours. Since then contrasts have increased as each new geological period has come into existence. Loss of heat in the earth, followed by contraction, has brought about increasing contrasts, and these have been followed by the rapid multiplication of differentiation adapted to the new conditions. Now, are we to suppose that this condition of things has not been continuous, and that climatic changes, with their attendant modifications of animal and vegetable life, had reached their maximum of differentiation, to be followed by a throw-back period, which accords with the sequence in the order of animal and plant life such as existed at the time when the Glacial period is said to have begun?

This Glacial period has been generally recognized by all the geologists of Europe and America, and the facts are such that it is evident glaciers or aqueous movements must have existed to a far greater extent than they do to-day over certain areas of the earth's surface. But, whilst granting this, is it necessary that causes should be sought for outside the ordinary physical phenomena which regulate the surface-changes such as are now going on? Is it possible to suppose that at some period of the earth's history a fresh-water lake could be sustained from the surplus drainage of an area equal in extent to that which is said to have been glaciated? For, if so, there appears to be no greater difficulty in supposing that with a slightly higher elevation the same amount of condensation could take place, and under special physical conditions like those now existing for the production of the Tasman and Franz-Josef Glaciers in New Zealand a so-called glaciated area could be produced equal in extent to what is said once to have existed in Europe or America. Let the fact be remembered that a Glacier is a secondary product, representing the surplus condensation beyond the snow-limit. As soon as the *névé* or *firn* exists there is a tendency in the plastic mass to move; but the movement is only possible below the snow-line so long as the supply is in excess of the melting-capacity of the sun's rays acting on the mass. The glaciated area of Europe represents

the excess of cold in the annual balance between the heat of the sun above and below the snow-line; but the heat below the snow-line may be equal to the maintenance of a warm, temperate flora, and yet be insufficient to melt the large accumulation of glacial ice from an area beyond the snow-line favourable to deposition and accumulation such as must have existed in order to produce glaciers like those which are supposed to have covered north-western Europe and a large portion of America, north of the parallel of 50° N.

The warm temperate flora of our own country in the midst of glaciers which descend to within 703ft. of sea-level shows that under favourable conditions glaciers can exist in close proximity to a rich and varied flora, capable of maintaining not merely an abundance but also a variety of animal life. But the seasonal contrasts such as prevailed in glaciated districts may have been even wider than those now prevailing within a given vertical and horizontal area, if we suppose, as is very probable, that the water- and land-areas were very different from what they now are. The surface of Europe shows that great earth-movements must have taken place during the later Tertiary period, and these movements were necessarily accompanied by the disappearance of some and the appearance of other river-basins. This fact, it appears to me, is too much overlooked at the present time by geologists. It is too often forgotten that denudations, aerial, aqueous, and æolian, are constantly modifying and destroying river-basins and bringing into being new ones; so that at the close of a period the differentiations may be supposed to have reached their maximum, there being numerous river-basins of small size separated from one another by low elevations; whilst the commencement of a period sees few rivers, of mighty size, the drainage of a single river embracing what is now understood as a "river system." This latter condition is, no doubt, what existed at the beginning of the period known as the Pleistocene, when the physical changes were such as to produce wide contrasts within the same area of vertical and horizontal space.

And that these contrasts existed seems to me assured if we consider what great varieties of aerial pressure are possible on the earth's surface at the present time in consequence of the inequalities of surface. First, let it be assumed that the land-area covering the earth is one-fourth that of the water-area. The average height of this surface above sea-level is 2,660ft. At sea-level the pressure of the atmosphere is on the average 15lb. to the square inch, which represents 31in. of barometric pressure. At 2,660ft. the pressure of the barometer is 28in., which corresponds to 13·5lb. to the square inch. By the graphic method this would give an average

pressure for the whole earth's surface at sea-level of 14·625lb. to the square inch. Fig. 1 :—

Pressure of Atmosphere.				
Water. 15lb.	Water. 15lb.	Water. 15lb.	Land (2,660ft.). 13·5lb.	Total for Earth. *Av.* 14·625lb.

Second, let it be supposed that the same area of land existed at the beginning of the Pleistocene period as at present, but that the contrasts were wider, and that the average height of the land was 10,200ft. The barometric pressure, assuming that the same aerial envelope surrounded the earth, would then have been 21in., which is equal to 10lb. to the square inch. This would give for the remaining three-fourths represented by the water-surface a pressure of 16·6lb. to the square inch, the height of the barometer over the same area being 33·33in. Fig. 2 illustrates this by the graphic method :—

Pressure of Atmosphere.				Height of Barometer in Water.
Water. 16·16lb.	Water. 16·16lb.	Water. 16·16lb.	Land (10,200ft.). 10lb.	33·33in.

As a third example, let it be assumed that half the earth's surface was occupied by the land at the opening of the Pleistocene period, the average height being 5,620ft. The barometric pressure over the land would average 25in., corresponding to 12·1lb. to the square inch. This would give a surface pressure over the other portion of the earth amounting to 17·15lb. to the square inch, the barometer showing a height of 35·43in. Fig. 3 illustrates this by the graphic method :—

Pressure of Atmosphere.	
Water, 17·15lb. bar. pressure to square inch.	Land, 12·1lb. bar. pressure to square inch.

We know the physical conditions resulting from the atmospheric pressure as shown in fig. 1, as these conditions exist now ; but what would probably be the characteristics of the animal and vegetable life assuming that the earth presented either of the conditions illustrated by figs. 2 and 3? Under fig. 1 the temperature contrasts may be assumed to vary

directly as the pressure; consequently the land and water contrasts at the present time are, on the average, comparatively small. But those contrasts widen under the conditions described in fig. 3, and they increase still more under the conditions assumed to exist in fig. 2. Now, it seems to me that either of the conditions illustrated in figs. 2 and 3 would be sufficient to bring about results such as the flora and fauna of the Pleistocene period show to have existed before, during, and after what is said to have been the glacial era. A pressure of 16·16lb. to the square inch under No. 2 condition, or of 17·15lb. under No. 3 condition, would have produced strong contrasts in the animal and vegetable world, for on the one hand the temperature in the area approaching the sea-level of the earth's surface must have been high, whilst in close proximity the high lands would undergo all the rapid changes of temperature such as one meets with in the higher regions of the atmosphere, where the air is so rare that it is unable to hold much moisture, and, as a result, radiation takes place at a very rapid rate.

Here, then, I think we may look for light in explaining the phenomena of the Glacial period, with its antecedent and subsequent changes. In his "Fragments of Earth-lore," page 270, Geikie says that "the Glacial, Pleistocene, and Post-glacial periods are not sharply defined, but merge," and he would like "one general term to include both. They form together a tolerably well-defined cycle of time, characterized by its remarkable climatic conditions, which were most strongly contrasted in the earlier stages of the period. Also, it appears that various oscillations of surface appear to have taken place again and again in the earlier and later stages of the cycle." The contrasts in temperature which must have taken place on the earth's surface during the progress of the physical changes such as I have shown to be possible without the help of external causes would produce all those characteristics which the glacialists say existed during the period claimed by them as glacial; but it further helps to explain why traces of that period are not to be found over the entire land-area known to geologists as the Pleistocene. The surface of the earth does not undergo depression and elevation synchronously. In one place areas may subside, in others they may be elevated, and representing the same geological period, and it may be that in one Pleistocene area the fossil life — both the fauna and flora — may show wide climatic variations, whilst in another there may be hardly a trace of such. In any case there seems to be no need to seek for external causes to bring about the cold period which marks the fossil fauna and flora of the later Pleistocene times. Earth-movements in combination with atmospheric pressure

are sufficient to bring about all the physical changes necessary, and the conditions I have offered in explanation are capable of producing all those phenomena which are characteristic of the period preceding, during, and following what is generally known as the Glacial period.

Art. LVII.—*On the Occurrence of Moa-footprints in the Bed of the Manawatu River, near Palmerston North.*

By H. Hill, F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 9th July, 1894.*]

Plate XLVII.

During a brief stay at Palmerston North, in February last, my attention was directed by Mr. H. J. Gilberd, one of our members, to some footprints of a bird he had lately discovered in the bed of the Manawatu River, not far from his place of residence. Being well acquainted with the character of the area in which similar footprints are found at the mouth of the Turanganui River, and having several of the footprints in my possession, I was curious to see whether the footprints and the deposits bore any resemblance to one another in the two localities. The place where the footprints under notice were found is situated towards the right bank of the Manawatu River, and about 6ft. above water-mark at the time of my visit. The place, however, must be covered with water, or nearly so, during the winter season. The top of the river-bank would be about 18ft. above the deposit containing the footprints. A recent flood in the river had washed away a portion of the river-bank, and a number of large-sized logs had become exposed, all of them lying parallel to the present flow of the river, and suggesting a different direction or flow at the time of their deposition. The deposit in which the trees are found is an alluvium running into a bluish sandy clay, which, however, does not appear to be of any large extent, as a shingle conglomerate is seen to underlie the alluvium in several places both above and below where the blue sandy clays rest on the conglomerates. The area where the footprints were was possibly a swamp or depression, which was filled by flood-waters heavily charged with clay and pumice-sands, and which became exposed as soon as the river assumed its normal flow. The deep impressions show

that the material was not fully hardened when it was traversed by several birds moving in the same general direction. It would seem that the impressions were subsequently filled by blown pumiceous sand, and it was in consequence of the washing-away of the overlying material and the movement of water over the surface containing the impressions that the softer sands were removed. The footprints are somewhat numerous, but only about eight of them were clear and distinct at the time of my visit. At my request, Mr. Gilberd measured the larger impressions, and it will be noticed that they are much larger than any of those found in the Poverty Bay deposits. From the end of the middle claw, which was very clearly shown, to the heel the length of the largest impressions were 15in., and within half an inch it was the same distance between the two outer claws. Another footprint measured 8¾in. from the end of the middle claw, whilst the distance between the two outer claws was 10in. In this impression the two outer toes were much deeper than the middle one, and it may be that the latter was not fully extended, owing to the material being somewhat harder. There were a number of smaller tracks about the same length as those found at Poverty Bay, but they were not so wide, and the claws were seen in most cases. Judging from the larger impressions only, the length of step was 26in. The peculiar character of the deposit made it hopeless to attempt to get out any of the impressions, and I had to content myself with making a rough sketch of several of the footprints (Plate XLVII.). I do not know whether the floods in the Manawatu since the date of my visit have washed away the deposit containing the footprints, but I expect this has been the case.

The age of the beds in which the footprints are found, both at Poverty Bay and in the Manawatu River, is later Pleistocene, corresponding to the later plain-deposits of the Heretaunga and Poverty Bay plains.

Art. LVIII.—*The Nuhaka Hot Springs.*

By H. Hill.

[*Read before the Hawke's Bay Philosophical Institute, 12th November, 1894.*]

I paid a visit to these springs on Monday, the 5th November, 1894. They are situated about six miles from the native settlement of Nuhaka, on the northern side of Hawke's Bay. Tongariro and the Nuhaka springs are in the same parallel of latitude. The Government have set aside a reserve of 640 acres, so that the springs will not fall into the hands of private owners. The country in which the springs are situated is of older Tertiary formation, and is similar to what one sees to the north of Gisborne along the coast, where the blue clays are interbedded with sandstone bands, which vary in thickness from a few to as many as 15 inches. The rocks at the point known as Tua Motu, to the north-east of Poverty Bay, are identical in structure with those in which the hot-springs are found. The springs are met with along the right bank of the Tunanui Stream, a tributary of the Nuhaka River, and about half a mile from the public road which, when completed, will bring this place into direct communication with Gisborne. Between Wairoa and the springs the road is already available for traffic, and, should the Government complete the road and establish a sanatorium, no doubt the springs will become the resort of numerous tourists. There are a number of hot-springs available for use, and when proper baths have been provided many persons will be able to use the waters without inconvenience. The water is very clear, and has a temperature varying from 105° to 120°. There are several basins suitable for use, the natives, since the discovery of the springs, having frequently brought their sick to partake of the healing waters. The springs belong to what are known as the chlorinated class, and contain much salt in solution. I drank somewhat plentifully of the water during the time I stayed to bathe, but it did not act in my case as an aperient, like the Cheltenham waters, with which the Government Analyst compares that at Nuhaka. The taste is not unpleasant, nor is there any unpleasantness in the water when cold, the taste being much similar to what I remember of the Cheltenham water many years ago. Mr. W. Skey, who has analysed the water, says it contains 1,723gr. per gallon of solid matter, only 22gr. of which is silica. The remainder is made up principally of alkaline chlorides, with a fair proportion of alkaline car-

bonates. The water is rich in iodine, and belongs to what is known as the alkaline chlorinated group. It should prove a valuable mineral water, as it resembles Wiesbaden, also that of Harrogate and Cheltenham, but is more highly charged with salt than they are, its specific gravity being equal to that of sea-water. It will thus be seen that the Government Analyst places the Nuhaka springs among an important and valuable class of mineral waters; and there can be no doubt that in kidney, liver, and cognate complaints the springs will prove of high public value. Many cases might be cited where the springs have proved highly effective; and it was with the view of bringing them under public notice that I lately visited them.

Distances: Wairoa to springs, twenty-six miles; Nuhaka to springs, six miles; Gisborne to springs, forty miles.

IV.—MISCELLANEOUS.

Art. LIX.—*Magnetization of Iron by High-frequency Discharges.*

By E. Rutherford, M.A.

[*Read before the Philosophical Institute of Canterbury, 7th November, 1894.*]

Plates XLVIII. and XLIX.

I. Magnetization of Iron by Leyden-jar Discharges.

The subject of the magnetization of iron in very rapidly-varying fields has been touched upon more or less fully by several different scientists, notably Dr. Lodge, Professor J. J. Thomson, Hertz, and a few others. In Dr. Lodge's "Modern Views of Electricity" we find the following: "But in the case of a discharge of a leyden-jar iron is of no advantage. The current oscillates so quickly that any iron introduced into the circuit, however subdivided into thin wires it may be, is protected from magnetism by inverse currents induced in its outer skin, and accordingly does not get magnetized, and, so far from increasing the inductance of the discharge circuit, it positively diminishes it by the reaction effect of these induced currents; it acts, in fact, much as a mass of copper might be expected to do."

In Fleming's "Alternate Current Transformer," vol. i., p. 398, there is a description of Dr. Lodge's experiments on the effect of iron in rapidly-varying fields: "With respect to the apparent superiority of iron, it would naturally be supposed that, since the magnetic permeability of iron bestows upon it greater inductance, it would form a less suitable conductor for discharging with great suddenness electrical energy. Owing to the fact that the current only penetrates into the skin of the conductor there is but little of the mass of the iron magnetized, even if these instantaneous discharges are capable of magnetizing iron . . . the electro-motive impulses, or sudden rushes of electricity, do not magnetize the iron, and hence do not find in it greater self-inductance than they would find in a non-magnetic but otherwise similar conductor."

Dr. Hertz, from his experiments on oscillating circuits, came to the conclusion that iron was not magnetic for very rapid frequencies; and, to quote from Fleming's abstract of Hertz's researches (vol. i., p. 416), "Hertz supposed that, as the self-inductance of iron wires is for slow alternations from eight to ten times that of copper wires, therefore a short iron wire would balance a long copper one; but this was not found to be the case, and he concludes that, owing to the great rapidity of the alternations, the magnetism of the iron is unable to follow them, and therefore has no effect on the self-induction." And again, p. 423: "When the wire was surrounded by an iron tube, or when it was replaced by an iron wire, no perceptible effect was obtained, confirming the conclusion previously arrived at that the magnetism of the iron is unable to follow such rapid oscillations, and therefore exerts no appreciable effect."

Steefan has, however, shown that we could expect very little alteration in the inductance of a wire, even if it were magnetic, on account of the greater concentration of the current in a magnetic conductor on the surface of the wire.

Professor J. J. Thomson ("Recent Researches," p. 322, and "Philosophical Magazine," 1891, p. 457) has shown that an iron cylinder placed in a solenoid absorbs considerably more energy than a similar non-magnetic conductor of equal conductivity, on account of the higher permeability of the iron.

J. Trowbridge ("Damping of Electric Oscillations": Phil. Mag., December, 1891) has shown that the resistance of iron wires damps electrical energy very considerably, and has deduced that iron must have a fairly high permeability to account for the effects observed.

Lastly, we have the statement, in the last page of Gray's "Absolute Measurements," that the damping of oscillations in a resonator is greater when the wire is of iron than when it is of copper.

In order to investigate the effect of "magnetic penetration" in iron for fields varying very much more rapidly than could be obtained with the use of the "time apparatus," the readiest means to hand for obtaining a very rapid oscillatory current was the ordinary leyden-jar discharge.

The subject of the magnetization of iron in these fields has been very little touched upon since the time that Henry experimented on the effect of leyden-jar discharges on the magnetization of steel needles.

In the experiments that follow it will be shown that iron is strongly magnetic in rapidly-varying fields, even when the frequency is over 100,000,000 per second.

A solenoid was wound on a small glass tube, sixty turns of wire, seven turns to the centimetre. A leyden-jar, charged up to a convenient potential by a Voss machine, discharged through this solenoid, and any iron, whether solid or finely divided, placed inside the solenoid was always more or less magnetized by the discharge.

Plate XLVIII., Fig. 1.

C, ordinary leyden-jar; A is solenoid; S, spark-gap.

The whole of the discharge passed through solenoid A. After the discharge had passed the needles were examined by means of a small mirror magnetometer. As this magnetometer is used in all future experiments for testing the magnetization of needles, the construction is briefly explained. It was made on the pattern set forth in Gray's "Absolute Measurements," vol. ii., p. 79. The needle was small, and arranged in a cavity, so that it was nearly dead-beat. The deflection was increased by means of a lamp and scale in the ordinary way. The value of the horizontal component at the needle was 0·22, and remained practically constant, as there were no masses of iron in the vicinity.

It was first settled that the needle placed in the solenoid was unaffected by the charging current from the Voss. The Voss was turned so as to charge up the jars just below the potential necessary to spark across knobs at S. The needle was then removed and tested by the magnetometer. No effect was observed.

The effect of discharges on needles of different diameters was first investigated. Length of needles, 7cm.:—

(1.) Part of steel knitting-needle, diameter 0·103in.: Deflection 112, at 9cm. distance from magnetometer needle.

(2.) Pianoforte steel wire, diameter 0·032in.: Deflection, 40; distance from magnetometer, 9cm.

(3.) Thin steel wire, diameter 0·008in.: Deflection, 10; distance from magnetometer, 9cm.

Diameter.	Deflection.
0·103in.	... 112
0·032in.	... 40
0·008in.	... 10

It will be observed from these experiments that the deflection is very nearly proportional to the diameter of the wire. This is to be expected, as the magnetizing forces are confined to a thin skin of the substance. The amount of the magnetization of the wire is proportional to the surface of the iron, and not to its sectional area, as it is for steady currents. In order to show that the effect was a surface one, and did not

penetrate any depth, a cylinder of thin copper was placed over the needle. The needle gave no appreciable deflection, showing that the copper cylinder completely screened off any effect on the iron. A thin external iron cylinder gave the same effect.

In order to determine with accuracy the state of a needle which had been under the influence of discharge, recourse was had to a method of solution of the iron. After several preliminary experiments, dilute HNO_3 at a temperature of boiling water was found to give the most reliable results. In order to test the rate at which the iron was eaten away a piece of pianoforte-wire 6·5cm. long, 0·032in. diameter, was taken and placed inside a solenoid, and subjected to a steady field of 100 C.G.S. units. The needle was then assumed to be magnetized uniformly throughout its section.

Plate XLVIII., Fig. 2.

E H F is a glass vessel, inside another glass vessel, A B C D, which is supported on a tripod of copper. Water is kept boiling in the outer vessel by a burner, K. Inside the inner vessel, but not touching it, is the needle, firmly fixed by the ends in a light frame. This frame is supported clear of the vessels by the stand, S.

The needle is fixed horizontally at a distance from the magnetometer, R, to give a convenient deflection on the scale. As the water is heated up to boiling-point the deflection due to the needle decreases slightly, due to the effect of temperature on the magnetic moment of the needle.

At a stand alongside, the dilute HNO_3 is kept in a beaker of boiling water, and when all is ready the HNO_3 is quickly transferred to the vessel E H F, taking care not to disturb the needle. The moment the HNO_3 reaches the level of the needle in the vessel the time is noted, for at that instant the needle commences to dissolve. Sufficient HNO_3 is poured in to cover the needle half an inch.

As the needle is dissolved the deflection falls, and the deflection at different intervals is carefully noted.

This method of fixing the needle first and then pouring in the acid was unavoidable, as the maximum deflection due to the needle could not otherwise be obtained. By keeping the HNO_3 at 100° C. and rapidly transferring it to the vessel (itself surrounded by boiling water) we insure that the needle is covered by HNO_3 at the same temperature during the whole time of solution. Since the amount of acid was large compared with the size of the needle, the effect of solution of the iron would not materially alter the rate at which the needle was dissolved.

A uniformly-magnetized steel needle was found to dissolve very regularly till it was reduced to an extremely fine filament, which did not break up until the magnetometer deflection had fallen within 3 div. of zero. The following is the result of an experiment on a uniformly-magnetized needle (needle 0·032in. in diameter; steady deflection just before acid is poured in = 222) :—

Time in Seconds after Solution begins.	Deflection.
0	222
30	217
49	195
56	177
90	157
115	147
139	137
206	107
246	97
311	77
373	57
414	47
454	37
566	17
638	7

It would be expected that the rate of solution of the metal at any instant would be : :^{a1} to the surface of the metal at that instant—that is, to the radius of the wire. This is very accurately the case in the above experiment. The deflection of the magnetometer at any instant is proportional to the sectional area of the wire—*i.e.*, to the square of the radius. The radius of the wire at any moment is therefore known.

If a curve is constructed whose abscissæ represent time, and ordinates the radii of the wire at different intervals, it will be found to be nearly a straight line, with the exception of an irregularity in the beginning of the curve.

A needle of steel 0·032 in diameter was then taken, and magnetized by passing the discharge from four leyden-jars in parallel through the solenoid. Spark-length, $\frac{1}{10}$in. A correction was made for the fall of deflection when needle was immersed in dilute HNO_3 at 100° C.

Plate XLVIII., Fig. 3.

The following is the table of observed values of time and deflection. The values of time and deflection are reduced for convenience in plotting curves :—

Abscissæ.	Ordinates.
0·0	8·5
0·7	12·5
1·7	14
3·2	15
4·2	15·3
5·2	15·6
6·2	15·5
7	15
8	14
9·2	12
10·5	10
11·7	8
12·9	6
14·4	4
16·2	2
18·2	1
20·2	0·5

The steady deflection at first was 85. As the iron commenced to be eaten away the deflection rapidly rose, and reached its maximum, 156. It remained stationary for a short interval at its maximum value, and then rapidly decreased down to zero. When the deflection had fallen to zero the needle was removed, its diameter measured, and found to be 0·013in. The depth of magnetic penetration was therefore about 0·0095in.

Now, from the results of experiments on the eating-away of uniformly-magnetized needles, we see that the depth to which the iron is dissolved is proportional to the time. Since in 200sec. the depth dissolved was 0·0095in., the rate of solution = 0·000047in. per second.

If I represent intensity of magnetization of a thin circular shell, distance r from centre of the needle, and M the deflection of the magnetometer at any instant,—

Then $\int \mathrm{I} \cdot 2\pi r \cdot dr$ is $::^{\mathrm{al}}$ to M;

$\therefore$ I . r is $::^{\mathrm{al}}$ to $\frac{d\mathrm{M}}{dr}$.

If a be radius of needle at first, it has been shown that $(a - r)$ is $::^{\mathrm{al}}$ to t (the time of action of acid).

Let $a - r = k \cdot t$,

then $-dr = k dt$,

and, substituting in equation (1), we get—

I $(a - kt)$ is $::^{\mathrm{al}}$ to $\frac{d\mathrm{M}}{dt}$, since dr is $::^{\mathrm{al}}$ to dt;

$\therefore$ I is $::^{\mathrm{al}}$ to $\frac{1}{a - kt} \cdot \frac{d\mathrm{M}}{dt}$.

Now, $\frac{dM}{dt}$ is the value of the tangent of the angle that the tangent at any point of the curve B (see Plate XLVIII., Fig. 3) makes with the axis of abscissæ. $\frac{dM}{dt}$ is $\therefore$ known from curve B. We can consequently determine the curve of variation of I from the surface to the centre, although there are not sufficient data to actually calculate I in absolute measure.

Plate XLVIII., Fig. 4.

The curve in Fig. 4 is an approximate representation of the magnetization from the surface inwards. The ordinates represent I, the intensity of magnetization. The abscissæ represent the distances from the external surface of wire.

It will be observed that the surface-layer is magnetized in an opposite direction to the main part of the magnetized metal.

As we go inwards from the surface the intensity of magnetization rapidly decreases till at the point A there is a portion of the metal which is not magnetized. This will be called the "neutral point."

On penetrating still further the magnetization changes sign, and rapidly rises to a maximum, which most probably represents an intensity corresponding to the saturation-point of steel. The intensity then remains practically constant till at D it decreases very rapidly down to zero.

It is evident from the manner in which the magnetization varies inwards that the iron has been under the influence of an oscillatory discharge. The first half-oscillation penetrated to a depth of $\frac{1}{100}$in., which is represented by the length O B in the figure. The neutral point A is at a depth of about $\frac{1}{400}$in. from the surface. The second half-oscillation has evidently decreased in amplitude considerably, since the depth of penetration is only a quarter that of the first discharge.

In this experiment there is only evidence of two half-oscillations. Several needles were examined which had been magnetized under the influence of various fields and different lengths of spark-gap, but the existence of the return oscillation could not with certainty be detected.

All the needles used gave the same general result—viz., a thin surface-layer magnetized in one direction, and a thicker interior layer magnetized in the opposite direction.

In one case examined the depth of penetration of the first discharge was considerably less than $\frac{1}{1000}$in.

The effect of varying the capacity of the condenser and keeping the self-inductance and the spark-gap constant was also investigated.

In the first experiment four leyden-jars were placed in parallel; the depth of penetration was found to be $\frac{1}{100}$in.

In next experiment two leyden-jars were placed in series; the depth of penetration was found to be 0·0035in.

∴ in first case discharge penetrates 2·8 times the distance of the second case. But the capacity in the first case was eight times that in the second case; $\sqrt{8} = 2{\cdot}8$, and therefore from this experiment we see that the depth of penetration is ::^{al} to the square root of the capacity.

But from the equation of discharge of leyden-jar of capacity C through inductance L the maximum current is given by

$$j = \frac{CV_0}{(LC)^{\frac{1}{2}}} e^{-\frac{R}{2L} \cdot t},$$

where V_0 is potential of charge, and R resistance in circuit.

The maximum current varies therefore as $\sqrt{C}$. The depth of penetration is therefore : :^{al} to the maximum current.

II. Effect of Continued Discharges on the Magnetism of a Needle.

It was observed that the magnetization of a needle was increased by sending a large number of discharges in one direction. In all the experiments that follow, a uniformly-magnetized steel needle was used, and the effect of a discharge in decreasing the deflection due to the needle was observed. A uniformly-magnetized needle has many advantages over an ordinary unmagnetized needle. These advantages need not be discussed at this point, for they will be sufficiently obvious as the paper proceeds.

A solenoid of a large number of turns was wound, and a battery current sent through it sufficient to produce a field of over 100 C.G.S. units in the solenoid. The steel needle was thus practically saturated when required by placing it in the solenoid and turning on the current.

Plate XLVIII., Fig. 5.

The condenser is charged by Voss or induction machine. In most of the later experiments an induction coil was used.

A B is a solenoid of about three turns per centimetre placed behind magnetometer. The needle was first saturated, and then placed in solenoid A B at such a distance from the magnetometer as to give a convenient deflection. When a spark occurred at S the deflection due to needle in A B fell. It was observed that the effect on the needle did not end with the first discharge, but the deflection fell gradually for every spark that passed, till finally the iron reached a steady state, and there was no further change of deflection, however many sparks were passed.

There was also a marked difference between the effects produced by discharges in opposite directions on the same saturated needle.

(1.) When the first half-oscillation tended to magnetize the needle in the same direction as it already was magnetized the first half-oscillation had no effect on the needle, it being already saturated. The second half-oscillation tended to demagnetize the needle, the third to magnetize it, and so on.

As an example of the effect of continued sparks in this direction we have the following:—

No. of Sparks.	Steady Deflection.
0	252
1	226
2	217
Several sparks	210

(2.) When first half-oscillation tended to demagnetize the needle the effect on the reduction of the deflection is much greater; for example:—

No. of Sparks.	Steady Deflection.
0	252
1	156
2	102
3	83
4	67
5	54
6	45
9	25
10	15
20 sparks	10

The deflection did not fall below 10 div., however many sparks were passed. The iron has then arrived at the steady state. The gradual demagnetization of iron by successive discharges is well illustrated by the above table. The cause of the effect was not at first clear, but further experiment showed that it was due to the very rapid damping of the oscillations. The first oscillation demagnetizes the surface-layers, and probably magnetizes a thin surface-shell to saturation in the opposite direction. The second half-oscillation wipes out some of this opposing magnetism, but to no appreciable depth, since the amplitude of the oscillation is by that time greatly reduced. The third half-oscillation tends to magnetize the iron again, and so on.

When another discharge is passed through the solenoid the first half-oscillation has first of all to demagnetize and magnetize the surface-layers in opposite direction to magnetism of needle. When it has penetrated through the thin surface-shell the magnetic force meets with a layer of iron of

low permeability, since the greater part is already magnetized nearly to saturation in the same direction by the action of the first half-oscillation of the first discharge. It therefore penetrates further, for we know the magnetic force penetrates deeper in a conductor like copper ($\mu=1$) than in a conductor like iron, where μ may be considerable. More iron is demagnetized and the deflection reduced. This continues as spark after spark is passed, till finally the discharge cannot penetrate any further. This corresponds to the steady state. It was found, by dissolving a needle acted on in this way by a succession of discharges, that the deflection rose steadily as the needle was eaten away, showing that the surface-layer was magnetized in an opposite direction to the central part.

In the experiment above detailed it was found that the discharge had penetrated to about one-quarter of the radius—*i.e.*, a distance of 0·008in. When thin steel needles were experimented on they were often totally demagnetized and magnetized in the opposite direction by successive discharges: *e.g.*, thin steel needle, 0·008in. diameter:—

(1.) Effect of second half-oscillation and succeeding—

Sparks.	Deflection.
0	150
1	80
2	55
3	50 &c.

(2.) Effect of first half-oscillation and succeeding—

Sparks.	Deflection.
0	150
1	−15
2	−120
3	−140

Soft iron as well as steel needles exhibited the same effect.

The difference between the effect of the first and the second half-oscillation in demagnetizing iron is very marked. The experiments show clearly how rapidly the oscillations decay in amplitude. When we are dealing with capacities of about 1,000 electrostatic units and small inductance in the circuit it seems very probable that there is only one complete oscillation. The others are damped down to such an extent as to be inappreciable. The fact that the deflection due to the needle always falls, whatever the direction of the first oscillation, shows clearly that the discharge is oscillatory. If there was only a unidirectional discharge the needle should only be affected when the discharge is in one direction.

Simple experiments of this nature on ordinary steel needles

show that a leyden-jar discharge is oscillatory, and show also the rapid decay of the amplitude of the vibrations.

A method of deducing the ratio of the second half-oscillation to the first will be given later.

The subject of the decay of amplitude of the vibrations of a leyden-jar discharge is of considerable interest, especially in connection with the resistance of spark-gaps and the radiation of energy into space.

Let L = self-inductance of discharge circuit for rapid alternations;
C = capacity of condenser;
V_0 = potential of jar;
R = resistance of connections and spark-gap to the discharge.

Then the current j at any instant is given by

$$j = \frac{CV_0}{(LC)^{\frac{1}{2}}} e^{-\frac{R}{2L} \cdot t} \sin. \frac{t}{(L\,C)^{\frac{1}{2}}}.$$

The exponential factor only includes the case of frictional dissipation of energy, and does not take into account radiation into space. In the experiments at present considered, where the condenser is a leyden-jar, the lines of force of which pass from one coating to the other, there can be a very small amount of dissipation of energy due to radiation ("Recent Researches," J. J. Thomson, p. 482). We can obtain a fairly accurate estimate of the decay of amplitude of the vibrations from the experiments of eating away of needles by HNO_3, but a more useful estimate may be obtained from considerations of the loss of magnetism of a needle as determined by a magnetometer.

Two small oppositely-wound solenoids, A and B, were placed in series connecting the coatings of an ordinary leyden-jar discharging through a spark-gap of $\frac{1}{10}$in. Two steel needles similar in all respects and magnetized to saturation were taken and placed in the solenoids A and B, so that their north poles faced in the same direction.

Plate XLVIII., Fig 6.

When the leyden-jar was discharged through the spark-gap the first half-oscillation tended to magnetize the needle in A to a greater extent; but, as it was practically saturated, no effect was produced. The second half-oscillation tended to demagnetize the needle, the third half-oscillation to magnetize it again, and so on.

On the needle in B, however, the first half-oscillation produced its full effect in demagnetizing, the second half tending to magnetize again, and so on.

On needle in A: First, third, fifth, seventh, &c., half-oscillations tend to magnetize needle in original direction; second, fourth, sixth, eighth, &c., tend to demagnetize needle.

On needle in B: Second, fourth, sixth, &c., tend to magnetize needle; first, third, fifth, &c., tend to demagnetize needle.

Now, the strength of field H in a solenoid of length large compared with its radius is given by

$$H = 4\pi nc$$

when n is number of turns per centimetre.

Now, suppose that the solenoids A and B are of the same number of turns per centimetre. Then the needle in B, since it is acted on by the first half-oscillation, will be demagnetized to a greater extent than the needle in A. The fall of the deflection in every case was readily determined by the small mirror magnetometer.

Let the number of turns per centimetre on solenoid B be reduced until there is exactly the same fall of deflection in each needle after one discharge. The maximum magnetizing force on needle in A = $4\pi nc$, where c is maximum current of second half-oscillation; the maximum magnetizing force on needle in B = $4\pi n'c'$, where n' = number of turns per centimetre, and c' = maximum current of first half-oscillation.

Now, since the effects on the needles are identical in the two cases, and the period is the same for both, the maximum magnetizing forces in the two solenoids must have been equal.

$$\therefore 4\pi nc = 4\pi n'c'.$$

$$\therefore \frac{c}{c'} = \frac{n'}{n},$$

or the maximum currents of the two half-oscillations are to one another inversely as the number of turns per centimetre on solenoids. There is, of course, an assumption here that the effect on the needles is $::^{al}$ to maximum magnetizing force when the period is constant. Experimentally it was found that the depth of penetration of magnetic force was $::^{al}$ to the maximum current ordinate when period was constant, and the assumption made is a very close approximation to the truth.

The connection between the depths of penetration when the periods varied was more complicated, and not expressed by any simple law.

In experimenting it was found advantageous to pass about twenty discharges instead of one, as the depth of penetration was greatly increased, and also the action of the first effective oscillation was in a great measure differentiated from the effect of the secondary ones.

Many experiments on the relation between the amplitudes

of the first and second half-oscillations were made under varying conditions. A few of these are incorporated in a "Note on the Resistance of Spark-gaps," placed at the end of this paper.

The general result obtained was that for a spark-gap of $\frac{1}{10}$in., and inductance of about 4,000 C.G.S. units in circuit, the amplitude of the second half-oscillation was less than half that of the first.

As an example of a balance of the kind explained, when 2·15 turns per centimetre were on the one solenoid and 1·06 turns per centimetre on the other the effect on the needles was exactly equal.

$$\therefore \left.\frac{\text{amplitude of second half-oscillation}}{\text{amplitude of first half-oscillation}}\right) = \frac{1{\cdot}06}{2{\cdot}15} = 0{\cdot}493,$$

or nearly one-half.

If this rate of decay holds for succeeding oscillations the return oscillation has only one-quarter of maximum value of first oscillation.

Plate XLVIII., Fig. 7.

The curve in Fig. 7 is a rough representation of the rapid decay of the oscillations. If the rate of decay continues for several oscillations the current will have a very small fraction of its original maximum value. It has been shown how a magnetized steel needle placed in a small solenoid may be used as a detector of an oscillatory discharge, and also as a means of determining the rate of decay of the oscillation.

A series of different experiments was then undertaken to show that iron possesses magnetic properties under the influence of all kinds of discharges.

The needle was placed in a solenoid connecting the external coatings of leyden-jars A and B, arranged as in Lodge's experiments on the "alternate path."

Plate XLVIII., Fig. 8.

A and B are two leyden-jars connected in series through the solenoid D. When a spark occurs at C there is an impulsive rush of electricity through the solenoid D. The steel or soft-iron wire placed in the solenoid exhibited the same effect as when the discharge occurs in the ordinary way. The wire was always demagnetized, and the loss of magnetism was almost exactly the same as when the jars are connected in series in the ordinary way and discharged. There was the same rate of decay of amplitude also, and, as far as regards the effect on magnetized needles, the impulsive discharge is of the same nature as the ordinary discharge.

(2.) The needle was next placed in a small solenoid in series with one of the long wires reaching from the coatings of the

condenser, as in Lodge's experiment on the velocity of electric radiation.

Plate XLIX., Fig. 9.

B D, T F, were a pair of wires, each about 20 yards long, leading from the condenser. This length was timed as far as possible to be in unison with the discharge at A: *i.e.*, the length of one of the wires was half a wave-length. With $\frac{1}{10}$in. spark at A, a spark of $\frac{3}{4}$in. could be obtained at spark-gap D, and the ends gave off a beautiful glow discharge every time a spark occurred at A.

The deflection of the needle always fell in value after a discharge, and there was not such a difference between the amplitude of the first and the second half-oscillation as in the previous cases.

With discharge in one direction deflection fell from 310 to 250; with discharge in opposite direction deflection fell from 300 to 255: showing that the first and second half-oscillations do not differ much in amplitude.

It seems very probable that when the long wires are timed in unison with the discharging current the rate of decay of vibrations in the long wires is independent of that of the discharging circuit. The long wires act as a resonator, and oscillate long after the oscillations in the vibrator have ceased. It made very little difference in the effect on the needle whether the knobs at the ends of the long wires were close together or far apart. To magnetize iron in rapid fields a closed circuit is not required. Another example of this will be given later.

From this and the previous experiment we see that iron is magnetic under the influence of impulsive rushes of electricity.

III. Effect of Induced Secondary Currents on the Magnetization of Iron.

Plate XLIX., Fig. 10.

A primary coil of ten turns of insulated wire was placed inside a glass tube, and a secondary of twelve turns outside the tube. A discharge was passed through the primary, and induced currents obtained in the secondary, giving a small spark at B. When a magnetized steel needle 0·032 in diameter was placed in a solenoid of three turns to the centimetre the deflection fell from 300 to 261.

In order to see the effect of resistance on the amount of current in the secondary, 10 yards of platinoid wire was placed in series with the secondary. Deflection fell from 300 to 285.

On removing platinoid wire and placing a copper wire of same length and section in its place very little difference in

the deflection was observed, although resistance of platinoid wire was 130 ohms and of the copper not more than 3 ohms. This shows that the quantity that flows in the secondary is practically independent of the resistance of the conductors.

This agrees with the theory; for if M be the coefficient of mutual induction between the two coils, and I self-induction of secondary, then the quantity of electricity circulating in the secondary is given by $\frac{M}{(R^2 + p^2L^2)^{\frac{1}{2}}}$, and when p is large R may be neglected in comparison with pL.

If L = 3,000, and frequency 2,000,000,
$p = 12 \times 10^6$ approximately,
$p\mathrm{L} = 36 \cdot 10^9$.

Therefore, in order that R^2 may be comparable with p^2L^2, R should be 10 ohms or more.

In the experiments considered, a short carbon rod of 10 ohms introduced into the circuit did not alter the effect on the needle, showing that pL must have been considerably greater in the experiment than in the calculation above. On adding a solenoid of sixty turns in the secondary the fall of deflection was scarcely appreciable, showing that the quantity circulating in the secondary depended on the inductance and not on the resistance of the conductors within wide limits.

IV. Experiments on the Dumb-bell Oscillator of Hertz.

In the experiments previously considered an ordinary short pianoforte-wire 0·032in. in diameter acted very well as a detector, but when we come to rates of oscillation of over 100,000,000 per second a more delicate detector is required.

Some very fine steel wire was taken, glass-hard, and cut up into lengths of 1cm. Twenty-four of these little needles were then built up into one, each being first dipped in paraffin to prevent eddy-currents passing from one wire to the other. This little collection of needles formed a compound magnet, and offered considerable surface to the action of rapidly-varying magnetizing forces. The detector was fixed in the end of a thin glass tube for convenience of handling.

This detector only retained about one-third of its magnetism, on account of the demagnetizing influence of its ends. When magnetized and placed in a solenoid of two or three turns it supplied an extremely sensitive means of detecting and measuring oscillatory currents of high frequency. It was far too sensitive to use in the ordinary leyden-jar experiments, for with one turn of wire round the tube it was completely demagnetized by a discharge.

For frequencies of 100,000,000 and upwards, however, where the quantities of electricity set in motion are in general small, it gave very satisfactory results.

Plate XLIX., Fig. 11.

B and C were two plates of metal about 20cm. square, arranged as in Hertz's experiment. A small solenoid of two turns (which did not use more than 2cm. of wire) was placed in series with discharge circuit at D. When an induction coil causes a discharge at A, oscillations are set up, which have a frequency in this case of over 100,000,000 per second.

When two turns were wound round the detector, the deflection fell from 300 to 250 in one direction and 300 to 274 in the other, showing that the decay of amplitude of the oscillations is about equal to that of the ordinary leyden-jar discharge.

It is unfortunate that I did not particularly distinguish between the "active" spark and the "ordinary" spark. Hertz had observed that the active spark was the only one that set up oscillations in neighbouring conductors; and from the very rapid decay of amplitude in this case it is almost certain that it was not the "active" spark that occurred.

This is confirmed by the fact that the effects on the needle differed very little whether the spark was obtained by the use of the Voss machine or from a Rumkhorff coil, while Hertz expressly states that oscillations in a neighbouring conductor are not excited unless a large Rumkhorff coil is used, and cannot be excited at all by the use of a Voss machine.

The effect of currents in a resonating circuit was next investigated.

Plate XLIX., Fig. 12.

This experiment was arranged after the same method as Hertz's experiments. C and C′ were two conductors of small capacity attached to ends of circuit in order to give discharging circuit a sensible capacity; *a b c d* was the resonating circuit, *m* spark-gap in resonator.

When discharge passed across B oscillations were set up in the resonating circuit. The detector was placed in the side *c a* of the resonator, and when there were three turns of wire round detector deflection fell from 300 to 253.

It was not at all necessary that a spark should occur at *m* to get an effect on needle, the effect being still considerable when the knobs at *m* were 1ft. or more apart.

If one side of the rectangle was removed an effect was still observed, but not of such magnitude as when the circuit was in unison with the primary.

In rapidly-oscillating fields, therefore, iron is magnetized in open circuit. The rapid surgings in a conductor are quite sufficient to demagnetize iron, and no complete circuit is required. The use of a sensitive detector as a means of investigating waves along wires will be discussed later.

It has been shown that iron still exhibits magnetic properties in fields of over 100,000,000 oscillations per second. A needle may be magnetized or demagnetized in open circuit by the oscillations set up in the wire.

More detailed experiments on the absorption of energy by iron cylinders and resistances of iron wires in rapidly-oscillating fields will now be entered upon.

V. Absorption of Energy by Conductors.

This subject has been treated mathematically and experimentally by J. J. Thomson ("Recent Researches," pages 321–326). He has there shown, by observing the effects of a discharge on a specially-prepared vacuum-tube, that an iron cylinder absorbs considerably more energy than a copper one. The experimental method pursued here is entirely different from Professor J. J. Thomson's, but the final results obtained are the same. The results are also quantitative, while Thomson's method only admitted of qualitative results.

Plate XLIX., Fig. 13.

An ordinary leyden-jar was discharged through a spark-gap A. In the discharge circuit was a solenoid C, consisting of about thirty turns, and 14cm. long, and about 1cm. in radius. A small coil B of three turns was used as a "detector" solenoid.

The magnetized detector was placed on the small solenoid, and about twenty discharges passed in one direction. The deflection due to the needle was then steady, and remained unaltered however many more discharges were passed.

Suppose, for example, the deflection fell from 200 to 100. The needle was again magnetized in a solenoid close at hand, and another twenty discharges passed in the opposite direction. If in this case the first oscillation tended to magnetize the iron and the second oscillation to demagnetize, the final deflection would be higher, as the amplitude of the second half-oscillation is less than that of the first. Suppose the deflection fell from 200 to 150, the needle was again magnetized and replaced.

A cylinder of iron was then placed in the large solenoid, and twenty discharges passed—(1) In one direction, (2) in opposite direction. In (1) the deflection fell from 200 to 103; in (2) the deflection fell from 200 to 162.

We see, then, that the effect of the iron cylinder in the

solenoid is to reduce the amplitude of the second half-oscillation considerably, for when the iron is removed and discharges passed the deflection falls from 200 to 150, and when the iron is in the solenoid from 200 to 162.

We must now consider to what this effect is due. If the iron increased the inductance of the circuit the effect would be to increase the amplitude of the second half-oscillation rather than decrease it. The iron cannot sensibly alter the inductance of the circuit, for we observe that the effect of the first half-oscillation is diminished very slightly—in this particular case from 200 to 100 to 200 to 103.

The result must therefore be due to an absorption of energy by the iron core, and a consequent increase of actual resistance in the circuit. The absorption of energy represents an addition of real resistance to the circuit, and increases the rate of dissipation of energy in the circuit.

The energy absorbed by the conductor may then be readily compared with the energy absorbed when a resistance of very small inductance is placed in the circuit—*e.g.*, a carbon pencil, or a tube containing an electrolyte.

The final deflection when the cylinder was in the solenoid was carefully observed. The cylinder was removed, and a short length of carbon rod of high resistance introduced into the circuit until the added resistance caused the final deflection to be the same as when the metal cylinder was in the solenoid.

Since the damping is identical in the two cases, the added resistance must absorb the same amount of energy as the metal core. The absorption of energy in the metal core therefore increases the impedance of the circuit, and this increase of impedance may be expressed in ohms.

The resistance of the carbon rod or electrolyte was determined for steady currents, and, since the conductivity is small, it will be found, by substitution in the equations given by Lord Rayleigh, that its resistance is practically the same for steady currents as for a frequency of 2,000,000 per second, which is very approximately the frequency of the discharge.

Proceeding in this way, the absorption of energy by various conductors was compared.

(1.) A test-tube was taken and filled with finely laminated soft-iron wires 0·008in. in diameter. In order to insure thoroughly good insulation from eddy-currents the test-tube was filled up with petroleum. The absorption of energy in this case increased the impedance of the circuit 10·25 ohms.

(2.) A test-tube full of steel filings was next placed in the solenoid. Increase of impedance, 9 ohms.

(3.) A thin soft-iron cylinder, 1·9cm. in diameter, 14cm. long. Increase of impedance, 3·9 ohms.

(4.) Solid iron rod. Increase of impedance, 3·5 ohms.

(5.) Copper cylinder, platinum cylinder, a test-tube filled with $CuSO_4$ solution, gave no appreciable absorption of energy.

(6.) A carbon rod, however, absorbed a large amount of energy. Increase of impedance of circuit, 3·3 ohms.

TABLE of Absorption of Energy by Various Conductors. (The absorption of energy is proportional to the increase of impedance of the circuit.)

Substance.	Increase of Impedance.
Laminated soft iron	10·25 ohms.
Solid soft iron	3·5 "
Carbon cylinder	3·3 "
Copper cylinder	Not appreciable.
Platinum cylinder	"
Steel filings	9·0 ohms.

Professor J. J. Thomson ("Recent Researches," pp. 321, 322) shows that the increase of impedance of the primary circuit due to absorption of energy by an iron cylinder of length l and radius a

$$= 4\pi^2 l \mathrm{N}^2 \left(\frac{p\mu\sigma}{2\pi}\right)^{\frac{1}{2}} a,$$

where $p = 2\pi n$; n being the number of oscillations per second;
N = number of turns per centimetre of solenoid;
μ = permeability of iron;
σ = specific resistance of iron.

Now, we have shown that a soft-iron cylinder increases the impedance of the circuit by 3·9 ohms.

From this equation we can deduce a rough approximation of the value of μ for iron in fields of high frequency.

The number of oscillations per second was 2,000,000, calculated from data of discharge circuit.

σ is approximate for soft iron, 10^4;
l = 14cm.;
a = 0·95cm.;
N = 2, nearly.

$$\therefore\ 3{\cdot}9 \times 10^9 = 4\pi^2 \times 14 \,.\, (2)^2 \left(\frac{2\pi \,.\, 2 \,.\, 10^6 \,.\, 10^4\mu}{2\pi}\right)^{\frac{1}{2}} 0{\cdot}95.$$

An approximate solution of this is $\mu = 172$, which shows that iron has considerable permeability even under the influence of these very transient fields.

It is interesting to observe that it is not necessarily the best conductors that absorb the most energy in these fields: in fact, the very reverse is the case. A copper cylinder does not absorb more than one-fortieth of the energy that an

iron cylinder of the same dimensions does, or one-thirtieth of the energy of a carbon rod of the same dimensions. It could always be told whether any considerable amount of energy was being absorbed in the solenoid by the peculiar deadened sound of the spark. A copper cylinder did not deaden the sound like an iron or carbon cylinder. The same sound was caused by adding a carbon rod in series with the circuit, so as to increase the resistance of the circuit.

VI. Resistances of Iron Wires for High-frequency Discharges.

Since iron has been shown to retain its magnetic properties in fields which are reversed a hundred million times per second, it was expected that the resistance of iron wires would be much greater for frequencies of several million per second than for steady fields, on account of the concentration of the current on the surface-skin of the conductor.

The resistances of conductors for these very rapid alternations have not yet been able to be determined, and so any method of attacking the difficulty is of interest. The method of experiment was practically the same as that used to determine the absorption of energy in conductors.

Plate XLIX., Fig. 14.

About 4 metres of iron wire were taken, and arranged in a rectangular discharge circuit. The other wire connections were copper conductors of the same diameter as the iron. The fall of deflection in the "detector" was observed for a series of discharges first in one direction and then in the other. The iron wire was then removed, and a copper wire of the same radius and length substituted. This insured that the self-inductance of the circuit was practically unaltered. A short carbon resistance was then added in the circuit until the fall of deflection with the copper wire and the carbon resistance was exactly the same as the fall of deflection in the case of the iron wire. Where this is the case, the resistance of the iron is equal to resistance of copper wire of equal length together with the carbon resistance.

Example of the Method of Determination.

When iron wire is in circuit, deflection falls—(1) From 200 to 103 for one direction; (2) from 200 to 176½ in opposite direction.

When the iron wire was removed, and a copper one substituted, the fall of deflection was—(1) From 200 to 101 for one direction; (2) from 200 to 162 for opposite direction.

On the addition of a carbon resistance of 8·5 ohms to the discharge circuit, the fall of the deflection was—(1) From 200 to 103; (2) from 200 to 176½.

Since the fall of deflection is the same in the two cases, resistance of iron wire = 8·5 ohms + resistance of the copper wire for that particular period. Now, from Lord Rayleigh's equations, the resistance of copper wire in rapidly-alternating fields is given by $R' = \sqrt{\frac{1}{2} p l R}$, where l = length of wire, and R is resistance of wire for steady currents. From knowledge of the period this may readily be calculated. The resistance of the iron wire is therefore known.

In order to determine the period very accurately, a plate condenser was used with ebonite as the dielectric. The S.I.C. of ebonite had been determined previously and found to be 2·2. The capacity of the condenser was found from calculation of the size of the plates to be 460 electrostatic units.

From knowledge of the data of the discharge circuit the self-inductance can be calculated. (See Lodge's "Experiments on Discharge of Leyden-jars," Proc. Roy. Soc., June 4, 1891, p. 33.)

The self-inductance $L = 4278$;

frequency $n = 2\pi\sqrt{LC}$

$= 3{\cdot}5 \times 10^6$;

and $p = 2\pi n = 2{\cdot}1 \times 10^7$.

The effect of the increase of diameter of wires on the self-inductance of the circuits is small, so that in all cases the number of oscillations per second will be taken as 3,500,000. When the resistances of iron wires of different sections were being determined a copper wire of as near as possible the diameter of the iron wire under consideration was placed in the circuit. In the case of an iron wire 0·22in. in diameter, a lead pipe took the place of the copper conductor.

After the calculated resistance of the copper wires for a frequency of 3,500,000 had been added to the carbon resistance placed in the circuit, the following is the table of resistances observed:—

Wire.	Diameter.	Resistance for Steady Currents.	Resistance for a Frequency of 3,500,000.
	In.	Ohms.	Ohms.
(1.) Soft iron	0·011	8·5	14
(2.) Soft iron	0·039	1·17	9·2
(3.) Steel pianoforte-wire ..	0·032	1·59	10·7
(4.) Nickel wire	0·043	0·59	7·2
(5.) Soft-iron wire	0·145	0·07	4·9
(6.) Soft-iron wire	0·222	0·032	4

It will be observed that for the soft-iron wire 0·222in. in diameter the resistance of the wire is 125 times its resistance for steady currents.

The wire 0·145in. in diameter is seventy times its ordinary resistance, and wire 0·039in. about eight times.

The general result of this investigation supports the theory of increase of resistance of conductors as the rapidity of the oscillations is increased.

The experiments here recorded receive additional confirmation from later investigations on the circular magnetization of iron.

It will be observed that the wire 0·011in. in diameter does not double its ordinary resistance for a frequency of 3,500,000, and the resistances increase more rapidly for increase of diameter than ordinary theory would lead us to expect.

Lord Rayleigh has shown that the resistance of a wire of permeability μ for rapidly-alternating fields is $\sqrt{\frac{1}{2}\mu p l}\mathrm{R}$, where R = resistance for steady currents.

Now, for wire of diameter 0·222in.,

$$\sqrt{\tfrac{1}{2}\mu p l}\mathrm{R} = 4\,;$$

and substituting $p = 2{\cdot}1 \times 10^7$,

$l = 377$,

$\mathrm{R} = 0{\cdot}032$ ohm,

we get an equation for μ, and it will be found that in this case $\mu = 121$; and, if we thus determine μ for the different soft-iron wires, we get the following table:—

Diameter.	Calculated Permeability.
0·011in.	5·8
0·039in.	18
0·145in.	87
0·222in.	121

It will be observed that the apparent permeability of the wire increases proportionately to the radius. Where the radius of wire is increased twenty times, permeability is increased twenty times, and so on.

I am not aware that anything definite on this subject has been hitherto done; but the following approximate calculation possibly gives the true explanation:—

Consider a condenser charged with a quantity Q_0 of electricity.

The maximum current of discharge $\mathrm{J} = p\mathrm{Q}_0$, assuming no decrease in amplitude.

Now, if this current be confined to a surface-skin of the conductor, the magnetic force, at a distance r from the centre, is given by

$$\mathrm{H} = \frac{2\mathrm{J}}{r}\,.$$

Now, this value of H at any point only depends on the current flowing external to that point; and, since the current is mainly confined to the surface, we may take r = radius of wire.

$H = \frac{2pQ_0}{r} = \frac{2}{r} pCV_0$, where V_0 is potential between knobs, and C is capacity of condenser.

As the spark-gap was $\frac{1}{10}$in. in length, the difference of potential was as near as possible 10,000 volts. Substituting these values, it will be found that

$$H = \frac{18{\cdot}8}{r} \text{ nearly.}$$

For the first wire $r = 0{\cdot}011\text{in.} = 0{\cdot}027\text{cm.}$

$$\therefore H = \frac{18{\cdot}8}{0{\cdot}013} = 1{,}400 \text{ approximately;}$$

and, taking B = 12,000, we get a value of

$$\mu = \frac{B}{H} = 9 \text{ approximately.}$$

The observed value is about 6; but the discrepancy between the two results is to be expected, and is due to the fact that the resistance of the iron is measured after a succession of discharges in the same direction, when, on account of the greater amplitude of the first half-oscillation, the inner part of the wire is practically saturated, and does not offer any considerable permeability when once the current has penetrated through the external skin, magnetized in the opposite direction by the second half-oscillation. The equations $H = \frac{2J}{r}$ and $\mu = \frac{B}{H} = \frac{Br}{2J}$ show that we should expect the permeability of the iron to vary as the radius of the wire, within, of course, the maximum limit of permeability of iron—*i.e.*, about 3,000. The table given previously shows how closely the law is fulfilled in practice.

Now, $J = pQ_0 = \frac{1}{\sqrt{LC}} CV_0$, and V_0 varies as the spark-length d.

$$\therefore J \propto \frac{\sqrt{C}}{\sqrt{L}} \cdot d,$$

and $\mu = \frac{Br}{2J}$, and when the iron is saturated B may be taken as constant.

$$\therefore \mu \propto \frac{r\sqrt{L}}{d\sqrt{C}}.$$

Therefore increase of radius increases the permeability of iron in these fields, and the shorter the spark-gap the higher the permeability, and therefore the resistance.

The resistance R′ for high frequencies $= \sqrt{\frac{1}{2}\mu_0 p l \mathrm{R}}$.

$$\therefore \ \mathrm{R}' \propto \sqrt{\frac{1}{2}\frac{r\sqrt{\mathrm{L}}}{d\sqrt{\mathrm{C}}} \cdot \frac{l}{\sqrt{\mathrm{CL}}} \cdot \frac{l}{r^2}}.$$

$$\propto \frac{1}{\sqrt{rcd}}, \text{ where } l \text{ is constant.}$$

The resistance of iron wires in these fields varies inversely as the root of the radius, inversely as the root of the capacity, and inversely as the root of the spark-length, and is independent of the inductance of the circuit.

The increase of resistance of iron wires for rapidly-alternating currents has been ascribed to the concentration of the current on the surface of the conductor. There is also, of course, loss of energy by hysteresis on account of the magnetization and demagnetization of the iron wire. Although much more energy is absorbed in steel than in soft iron, due to hysteresis, the steel wire did not show any greater increase of resistance than the soft-iron wire. It seems, therefore, that the effect of hysteresis may be neglected as a factor in determining the increase of resistance of wires.

It is possible that the absorption of energy due to hysteresis may be much greater for a frequency of several millions than for frequencies of 1,000; but it is a very difficult matter to separate the effects of induced currents from those of hysteresis in causing absorption of energy in an iron cylinder.

VII. On the Division of Rapidly-alternating Currents in Multiple Circuits, and the Effect of Metal Cores on the Distribution of the Current.

Plate XLIX., Fig. 15.

Consider the distribution of an alternating current between two conductors A C B, A D B, in parallel.

Let R and L be resistance and self-inductance respectively in branch A C B.

Let S and N be resistance and self-inductance respectively in branch A D B.

If y be current in branch A C B, and $x-y$ be current in branch A D B, then it is shown ("Recent Researches," p. 513) that for rapid alternations the distribution is such that

$$y = \left\{\frac{\mathrm{S}^2 + \mathrm{N}^2p^2}{(\mathrm{L}+\mathrm{N})^2 + (\mathrm{R}+\mathrm{S})^2}\right\}^{\frac{1}{2}} \cos.\ (pt + \epsilon),$$

$$x - y = \left\{\frac{\mathrm{R}^2 + \mathrm{L}^2p^2}{(\mathrm{L}+\mathrm{N})^2 + (\mathrm{R}+\mathrm{S})^2}\right\}^{\frac{1}{2}} \cos.\ (pt + \epsilon'),$$

where $$\tan.\ \epsilon = \frac{p\,(\mathrm{RN} - \mathrm{SL})}{\mathrm{S}\,(\mathrm{R}+\mathrm{S}) + \mathrm{N}\,(\mathrm{L}+\mathrm{N})\,p^2},$$

and $$\tan.\ \epsilon' = \frac{-p\,(\mathrm{RN} - \mathrm{SL})}{\mathrm{R}\,(\mathrm{R}+\mathrm{S}) + (\mathrm{L}+\mathrm{N})\,\mathrm{L}p^2}.$$

The maximum currents flowing in the two branches are proportional to the quantities under the roots, and it will be observed that the distribution of current for high frequencies depends more on the self-inductance than on the resistance of the circuit.

The two circuits were wound exactly equal to one another. Each consisted of a solenoid of 34 turns, 22cm. long, 2·2cm. in diameter. The wire was indiarubber-covered copper wire 0·039in. in diameter.

When a metal core is introduced into the solenoid and a discharge passed there are vigorous induced currents in the cylinder. When it is considered that a current of sometimes 100 amperes is reversed 10,000,000 times per second, the induced currents must be large. These induced currents, on account of the very short time which they last, are confined to a thin skin of the cylinder. But these induced currents tend to diminish the effective inductance of the circuit. The amount of energy absorbed in the cylinder depends on the difference of phase between the direct and induced currents. The impedance of the circuit is given by $\sqrt{R^2 + p^2L^2}$, and it is of interest to know whether this is increased or decreased by the introduction of a metal core.

(1.) A copper cylinder 1cm. in radius was introduced into one solenoid. By the use of an ordinary detector it was found that more current flowed in the branch in which the copper cylinder was placed than in the other branch. The amount of current in one branch was 8 per cent. more than in the other. Now, from the expressions given for the distribution of current in each branch, it will be seen that the denominators of the expressions are the same, and the numerators represent the impedances of the circuits. The value of $\sqrt{R^2 + p^2L^2}$ is decreased by about 8 per cent. by the introduction of the copper cylinder, or the effect of a copper core is to *diminish the impedance* of the circuit.

(2.) When a lead cylinder was introduced in place of the copper no effect of unequal distribution could be with certainty detected.

(3.) *Magnetic Cylinders.*—(*a.*) When a solid soft-iron cylinder was introduced into the solenoid the current in that branch was diminished by about 3½ per cent. (*b.*) Laminated soft-iron wires placed in test-tube and thoroughly insulated from one another decreased the current in its branch by more than 12 per cent. (*c.*) Steel filings in a test-tube also decreased the current in its branch.

The effect of iron, whether solid or finely divided, is therefore to increase the impedance of the circuit.

This is the general result obtained for a frequency of about

3,000,000 per second, but whether the increase of impedance is due chiefly to an increase of R or of L, or both, cannot be definitely settled; but from experiments of the great absorption of energy of iron cylinders it is most probable that the increase of the impedance is due to an increase in R, and not to an increase in L.

A far more delicate arrangement for detecting differences of resistance and inductance in circuits was used in further experiments. A differentially-wound solenoid was used with one coil in one branch and a similar coil in the other, such that when the currents in each branch were alike in amount and phase there was no effect on the "detector" placed in the solenoid. If a metal core was introduced into either solenoid the balance was greatly disturbed, and in this way the results of previous experiments were confirmed. The method offered a very convenient means of determining the resistance of iron wires, and the values obtained were quite in accordance with previous results.

VIII. Circular Magnetization of Iron Wires.

While experimenting on the resistance of iron wires which passed close to the magnetometer, it was observed that the deflection of the magnetometer varied very considerably with the direction of the discharge, and also with the number of discharges. The reason was at first not clear, but subsequent investigation showed that it was due to the magnetization of a neighbouring part of the wire by the transient current that passed through it. When the wire was quite straight no effect was observed, but if a slight bend was made near the magnetometer the deflection varied according to the direction of the discharge. The effect was very marked both in soft-iron and steel wires, and shows what heavy momentary currents must be circulating in the wires, for a steady current of 10 amperes did not affect the deflection appreciably. The effect of discharges through a short wire magnetized longitudinally was then investigated. The discharge always reduced the magnetization, whether the wire was of soft iron or steel. This apparent demagnetization of the iron was due to the surface-skin being "circularly" magnetized by the longitudinal current through the wire. The heavier the transient current the greater was the fall of magnetization.

The following are examples of a few of the experiments on the fall of deflection when the frequency of discharge was 3,000,000 and the value of the maximum current about 100 amperes:—

(1.) Thin soft-iron wire, 0·01in. in diameter: Completely demagnetized.

(2.) Thin steel wire, 0·01in. in diameter: Completely demagnetized.

(3.) Pianoforte steel-wire, 0·032in. in diameter: Deflection fell from 250 to 116.

(4.) Steel needle, 0·065in. in diameter: Deflection fell from 250 to 184.

(5.) Thick steel needle, 0·102in. in diameter: Fall of deflection from 250 to 216.

(6.) Hollow soft-iron cylinder, $\frac{1}{4}$mm. thick, diameter 18mm., length 16cm.: Fall of deflection, 250 to 230.

The same condenser and discharging circuit were used for all the specimens tested, and it is of interest to observe the depth of penetration inwards, assuming the residual deflection is given by the mass of iron not circularly magnetized—*i.e.*, not affected by the current in the surface-skin of the conductor.

Wire.	Diameter.	Depth of Penetration of the Discharge.
	In.	In.
Hard-steel wire	0·032	0·0051
Soft-steel wire	0·065	0·00455
Soft-steel wire	0·102	0·00357
Soft-iron cylinder	0·72	0·00044

Experiments of this kind show to what a small depth the current penetrates into the wire. Very large momentary currents are conveyed through a thin surface-skin of the conductor, and the intensity of the current diminishes rapidly inwards.

The loss of deflection due to the "circular magnetization" of a wire by the passage of a longitudinal current is a very convenient method of estimating the quantities of electricity that flow in the branches of multiple circuits.

The currents in this case are all of the same frequency, and, experimentally, it was found that the "depth of penetration" was proportional to the maximum current.

By taking short steel needles magnetized to saturation and placing them in series with circuits in multiple arc, the division of the current among the conductors admits of accurate determination. By varying the diameter of the needles, currents of the same period but widely different amplitudes may be compared.

J. J. Thomson has suggested a specially-prepared vacuum-tube placed in a solenoid as a convenient galvanometer for discharges of this kind. The comparison between the currents in the various branches is made by observations on the brilliancy of the discharge in the bulb. The effect of a longi-

tudinal current on the magnetism of a needle, however, not only gives a qualitative method of comparison, but also very accurate quantitative results.

In the earlier part of this paper it has been shown that a magnetized needle is demagnetized considerably under the influence of an oscillating discharge of a frequency of about 100,000,000, such as is obtained from Hertz's dumb-bell oscillator.

Plate XLIX., Fig. 16.

A and B were two metal plates of small capacity, S the spark-gap. A small steel needle, C D, diameter 0·01in., was placed in the discharge circuit. After the passage of several discharges the deflection of the needle fell from 300 to 250: this corresponds to a depth of penetration of the discharge of about 0·00045in. Sending several discharges in the same direction had the effect of decreasing the deflection till a steady state was arrived at, exactly as in the case of the demagnetization of iron needles in solenoids.

From the magnitude of the effect we have been considering, it is evident that a thin magnetized needle is a very convenient galvanometer for the measurement of the intensity of electric waves at different parts of a circuit vibrating freely.

In order to see if this were the case, the experimental arrangement of Hertz for showing the existence of waves along wires was used.

Plate XLIX., Fig. 17.

The plate B was about 10cm. behind the plate A. A wire was taken from B to C, about 5 metres long.

If the end C were free and insulated, and the small detector placed in series near the end, no effect on the needle was produced. If a metal plate were fixed to the end C, there was immediately a fall of deflection of 50 divisions when the vibrator was set working. This shows that when the end is free the point C is a position of minimum current, and when the plate is added the current is a maximum at C. On leaving the end free, and moving the needle to different distances from C, the fall of deflection gradually increased, and then diminished again.

The experiment was not proceeded with, as the subject of the distribution of waves along wires has been worked out experimentally by several methods. It shows, however, that a magnetized needle is a very convenient galvanometer for oscillating circuits for frequencies up to 500,000,000 per second.

The effects on fine steel wire, whether placed in series or in a solenoid of several turns, may be used as a means of

detecting electro-magnetic radiation, and of investigating the waves in free vibrating circuits.

Before starting this research I was uncertain whether iron was magnetic in very rapidly-oscillating fields or not. The only information I could obtain on the subject is given in the opening pages. What experimental evidence there was seemed vague and contradictory. In this research, starting from the magnetization of iron in ordinary leyden-jar discharges, it has been shown that iron is magnetic for frequencies up to 500,000,000 per second. On account of the small quantities of electricity set in motion the experiments were not pursued further, but I have no doubt that by the use of very thin steel wires iron may be shown to be strongly magnetic for the highest frequencies yet obtained. If the molecules of iron can follow the changes of magnetic force, which is reversed 1,000,000,000 times per second, there can be very little magnetic viscosity, and the molecules must move as freely as when under the influence of an alternating current of 100 per second.

Iron has been shown to absorb energy and exhibit high permeability in very rapidly varying fields; the absorption of energy has also been accurately measured. The resistance of iron wires for leyden-jar discharges has been investigated, and an approximate theory advanced to account for the effects observed. In one case the resistance has been shown to be 120 times the resistance for steady currents.

The division of currents in multiple circuits has been investigated in several cases, and it has been shown that iron, whether solid or finely divided, always increases the impedance of a circuit.

The use of magnetized steel needles as "detectors" and "galvanometers" has been explained, and their possible use also for measurement of the intensity of electro-magnetic waves.

Information with regard to the nature of the discharges and the damping of vibrations has been obtained in the course of the experiments.

A more detailed though imperfect note is appended on the "Resistance of Spark-gaps," a subject on which little seems to be at present known.

NOTE ON RESISTANCE OF SPARK-GAPS.

When a leyden-jar is discharged a bright flash of light is the only apparent result of the energy stored up in the dielectric of the jar. The energy of the discharge, however, has been dissipated, due to several distinct causes.

(1.) The spark-gap offered resistance to the discharge, and energy has been dissipated in the air-space according to Joule's law.

(2.) The wires and connections of the discharge circuit have also dissipated part of the energy into heat. It must be remembered in this connection that the resistance of wires for leyden-jar discharges is often much greater than for steady currents.

(3.) Part also has been radiated away into space as electromagnetic waves. The amount of this radiation varies greatly with the type of condenser used. An ordinary leyden-jar is a poor radiator, but Hertz's dumb-bell vibrator is a good radiator and the oscillations are rapidly damped down.

(4.) Part also has been absorbed in the dielectric, due to molecular hysteresis in the glass. The amount of this is not known with certainty, and it most probably varies greatly with the kind of glass used.

For the ordinary leyden-jar most of the energy is wasted in heat in the spark-gap, and the number of complete oscillations that occur depends almost entirely on the length of spark-gap. Indirect evidence of the rapid damping-down of vibrations is afforded by experiments on resonators. If the discharge circuits of two equal condensers be exactly equal and facing one another, a few feet apart, when one jar is discharged oscillations are set up in the neighbouring circuit, and since the periods of the two systems are the same the well-timed impulses due to the vibrator will cause sparking in the resonator.

The distance to which this sparking may be detected depends almost entirely on the length of the spark-gap in the circuit of the vibrator. When the spark-gap is long, although the first oscillation is very vigorous no sparks can be detected in the resonator more than a few feet away. As the spark-gap is shortened the oscillations of the vibrator diminish in amplitude, but are more persistent on account of the lower resistance in the spark-gap, and, as the resonator responds more readily to a succession of small impulses than to one vigorous impulse, sparking may be detected to a much greater distance. For spark-gaps greater than $\frac{1}{10}$in. in length an ordinary discharge is damped down extremely rapidly, and the amplitude of the second swing is generally less than a fifth of the first.

When a discharge occurs in currents of known inductance and capacity the theoretical law of decay is known. The current J at any instant t is given by

$$J = \frac{CV_0}{(LC)^{\frac{1}{2}}} e^{-\frac{R}{2L} \cdot t} \sin. \frac{t}{(LC)^{\frac{1}{2}}}$$

where L = inductance of circuit for rapid oscillation,
R = resistance of leads and spark-gap,
C = capacity of jar,
V_0 = potential of coatings.

The maximum current of the first half-oscillation is given by

$$J_1 = \frac{CV_0}{(LC)^{\frac{1}{2}}} e^{-\frac{R}{2L} \cdot \frac{T}{4}},$$

where T is period of a complete oscillation.

The maximum current of the second half-oscillation is given by

$$J_2 = \frac{CV_0}{(LC)^{\frac{1}{2}}} e^{-\frac{R}{2L} \cdot \frac{3T}{4}}.$$

$$\therefore \log. \frac{J_1}{J_2} = \frac{R}{2L} \cdot \frac{T}{2}. \qquad (A.)$$

The ratio $\frac{J_1}{J_2}$ can be obtained by the method of experiment previously explained; and, since T and L are known from the data of the condenser and the discharge circuit, R is known. Now, R is made up of the resistance of the leads as well as the spark-gap. The resistance of the leads can be deduced from Rayleigh's formula, and therefore the resistance of the spark-gap between the first and second half-oscillations is known.

An experimental method of calculation was also used as a means of checking the results obtained from above equation. After the ratio $\frac{J_1}{J_2}$ had been determined by varying the number of turns in a solenoid, a known carbon resistance, r, was introduced into the circuit, and the ratio, $\frac{J_3}{J_4}$, of the first two half-oscillations determined as before.

$$\therefore \log. \frac{J_3}{J_4} = \frac{(R + r)}{2L} \cdot \frac{T}{2}. \qquad (B.)$$

Dividing equation (B) by (A), we get—

$$\frac{R + r}{R} = \frac{\log. \frac{J_3}{J_4}}{\log. \frac{J_1}{J_2}}.$$

Therefore R is known at once.

Proceeding in this way, the resistances of spark-gaps when the self-inductance and spark-length were constant and the capacity varied were determined. The spark-gap was $\frac{1}{10}$in. in length, and between knobs 1cm. in radius.

Condenser.	Capacity.	Ratio of Amplitude of First to Second Half-oscillation.	Resistance of Spark-gap in Ohms.
			Ohms.
Two leyden-jars in series ..	500	2·55	50·5
Plate condenser	576	2·42	49·3
One leyden-jar	1,000	1·85	24·5
Two leyden-jars in parallel ..	2,000	1·84	17·2
Four leyden-jars in parallel ..	4,000	2·01	13·6
Six jars in parallel	6,000	2·1	10·5

A Voss machine was used to charge up the jars. It will be seen that the resistance of the spark-gap diminishes rapidly as the capacity of the condenser is increased—*i.e.*, as the quantity of electricity that passes through the spark-gap is increased.

The effect of keeping the capacity and inductance constant and varying the spark-length was then proceeded with.

Length of Spark-gap.	Ratio of Amplitudes of First Two Half-oscillations.	Resistance of Spark-gap in Ohms.
In.		Ohms.
0·014	1·31	14·8
0·028	1·44	19·8
0·089	2·31	47·8
0·1	2·42	51·3
0·142	2·91	60
0·231	4·4	81

These observations show that the spark-gap increases in resistance rapidly as the length of spark is increased. Short spark-gaps have low resistances, and long spark-gaps high resistances.

In all these experiments a Voss machine was used to charge up the jars. If the Voss is replaced by a Rumkhorff coil, under certain conditions it is probable that the resistance is much lower. If a Hertz dumb-bell vibrator is excited by a Voss no action in a resonator can be detected. When a Rumkhorff coil is used oscillations are set up in neighbouring circuits, but only when a certain kind of spark is given by the coil. This spark was called by Hertz the "active" spark, and it is probable that the resistance of the spark-gap is much less with the active spark than with the ordinary discharge. Usually with a spark-gap of about $\frac{2}{3}$cm. the vibrations are damped down very rapidly, and the second half-oscillation has not half the amplitude of the first.

In the course of one experiment I tried whether there was any difference in the resistance of the gap when a Voss was used or a coil. The results were,—

(1.) The condenser was charged up to a slightly greater difference of potential by the Rumkhorff than by the Voss for the same length of spark-gap.

(2.) The resistance of the spark-gap for the Rumkhorff coil discharge was slightly less than in the case of the Voss.

These are the results of a few preliminary experiments into this little-known subject. I have reserved a more complete investigation for a future occasion.

ART. LX.—*The Last Glacial Epoch: explained by Major-General Drayson's Discovery of the Second Rotation of the Earth.*

By Major-General SCHAW, C.B., R.E.

[*Read before the Wellington Philosophical Society, 13th June, 1894.*]

Plate XLV.

As you have re-elected me as your President for the present year, the duty once more devolves upon me to open the session by an inaugural address, and I have chosen as my subject one which I hope may give rise to some interesting and instructive discussion—namely, that slow movement of the north pole of our earth which has long been known in an imperfect manner, but which has now been reduced to mathematical exactness by Major-General Drayson, and discovered by him to be caused by a second rotation with a very long period. The bearing of this discovery upon the date and duration of the last glacial epoch, and the explanation which it affords of that peculiar epoch of the earth's history which immediately preceded man's appearance, are extremely interesting, and I propose to bring the whole matter briefly in review before you this evening.

In speaking of an ice age or a glacial epoch, I do not refer to anything like a cataclysm, but simply to an extension southwards in the Northern Hemisphere and northwards in the Southern Hemisphere of climatic conditions such as now exist within and near the arctic and antarctic circles. And I assume that this extension of refrigeration was not sudden in its beginning or its ending, but was gradual and slow, and that the effects of such refrigeration were different in different

places, just as we see that there are very great differences now in climate between places in the same latitudes but under different conditions as to heights above the sea, moisture, and the vicinity of cold or warm ocean-currents, &c. With these explanations I may confidently assert that it is a fact, supported by such a mass of geological evidence as to put it beyond the possibility of doubt, that there was a time in this world's history—comparatively recent from a geological point of view—when climatic conditions somewhat resembling those now existing in Greenland and other arctic and antarctic regions extended very much farther south in the Northern Hemisphere, and also very much farther north in the Southern Hemisphere, than at present. It is, perhaps, not yet quite certain that this glacial condition in the Southern Hemisphere was synchronous with the glacial condition in the Northern Hemisphere, but I believe that the geological evidence is in favour of this conclusion. This remarkable fact in the history of our globe has given rise to much speculation, inquiry, and discussion. The questions to be solved were three: 1. When did this ice age terminate? 2. How long had it lasted? 3. What was the cause which produced it, and why did this cause cease to act? In no part of the world has the ice age left its record so completely and on so grand a scale as in North America. The record has there been studied most carefully and exhaustively; and fortunately there are in that country several cases in which rivers, which, from the circumstances of the case, could not have been flowing during the ice age, have cut back new channels at waterfalls, since the disappearance of the ice, for distances which, when compared with the rate at which the edges of the waterfalls have retrograded during recent times, give a fair measure of the time during which these rivers have acted, and therefore of the date when glacial conditions ceased there. The Niagara Falls is the best known of these instances; but falls on the Missouri at St. Anthony and on other rivers have given similar evidence; and the general result arrived at is that the glacial condition, both in North America and in Europe, terminated from 10,000 to 8,000, or even less, years ago. The duration of the glacial condition has been estimated approximately by American geologists at from 12,000 to 24,000 years, and by Professor Prestwich at from 15,000 to 25,000 years. These latter are wide margins; but the data, chiefly the masses of moraine left by the retreating ice, and the distances travelled by erratic boulders compared with known rates of glacier motions, are so imperfect that probably no nearer approximation can be made geologically. The theory of two separate ice ages in succession has been upheld by some; but it is now discredited in America, the appearances which seemed to indicate these

successive waves of cold having been more carefully interpreted by comparison with existing glaciers, and having been explained by the alternate advances and retirements of glacier faces according as the seasons during the Glacial period were more or less favourable to the deposition of snow or to its melting away.

In North America, the glacial condition extended on the east coast as far south as New York, in lat. 41°; it swept as far south as lat. 38° in the valley of the Mississippi, whence the boundary stretched north-west to about lat. 46° 30′ on the west coast, with great southward extensions on the mountain-ranges of the Rockies, the Sierra Madre, and the Sierra Nevada and Cascade Ranges, to lat. 42°, 38°, and 36° N.

In Europe, ice and snow overwhelmed the whole of Ireland, Scotland, Wales, and England as far south as the valley of the Thames in lat. 51° 30′, stretched across to Holland and North Germany, trended south to the Carpathian Mountains in lat. 48° N., stretched across Russia to the valley of the Volga in an irregular line, a little north of the 50th parallel of north latitude, and thence struck northwards to the Ural Mountains in lat. 63°, and so back to the Arctic Ocean. The Alpine glaciers formed an outlying glacial sea overwhelming Switzerland and North Italy, and invading France by the valley of the Rhone to lat. 46°.

Two remarkable facts are evidenced by these boundaries of the glaciated regions in America and Europe. First, we notice that the Gulf Stream must have had the same sort of influence during the glacial age that it has now; for the glacial conditions on the east coast of North America extended as far south as lat. 41°, while on the west coast of Europe they did not reach farther than lat. 51° 30′. It is probable that this was the limit of the northward flow of the Gulf Stream in the ice age, at least in winter, when the North Sea must have been blocked with ice, and the Arctic Ocean must have formed an icy barrier between Greenland, Iceland, and the British Isles.

Secondly, we notice how necessary moisture is for the formation of glaciers, as there is no geological evidence of any glacial action in north central Asia; it is confined to the parts of Europe subjected to the moist winds from the Atlantic and the northern seas. In North America the great lake-system was evidently much extended during the ice age, and thus the needed moisture was afforded in the central parts of North America where glacial conditions prevailed.

In Siberia and Kamschatka and north-west Alaska the climate is very dry, and, although the cold is intense, the effect produced is not the formation of glaciers, but what is known as tundra, where the soil is perpetually frozen for hundreds of

feet in depth, a few feet of the surface being thawed in summer and supporting a peculiar vegetation. In such countries the ice age has naturally left no record.

In the Southern Hemisphere the only existing land-surfaces which probably could have been affected by an ice age are Tierra del Fuego and Patagonia at the south extremity of South America, New Zealand and Tasmania, and in some slight degree South Australia. Of the former countries we have no sufficient exploration to give complete geological data on which to reason as to the extent of glaciation they may have undergone in the past; but Darwin found erratic boulders in lat. 41° to 43° on Chiloe Island, evidently brought by glaciers from the Cordilleras, and on the east coast he found similar boulders in Santa Cruz valley, lat. 50°, but he did not examine the country farther north. At present we have the remarkable fact that the mountains on the west coast of South America, as far north as the Gulf of Penas, lat. 46° 52′, send large glaciers down to the sea-coast, where icebergs are formed, and this although the mountains there do not exceed 6,000ft. in height. The degree of cold experienced so far north on this coast is, however, explained by the existence of a cold antarctic current, which, starting apparently to the east of the projecting antarctic land called South Victoria, circles round to the north and east until it strikes the west coast of Patagonia in lat. 48°, where it divides, part going up the coast northwards until it merges in the west-flowing equatorial current, part flowing south and sweeping round Cape Horn, and continuing onwards in a north-easterly direction into the South Atlantic. This cold antarctic current performs for the south-west of South America a similar but opposite office to that which the warm Gulf Stream performs for the north-west of Europe, and, just as the Gulf Stream gives north-western Europe an abnormally high temperature, so this antarctic cold stream gives an abnormally low temperature to the south-western coast of South America. The south-east coast has a much more genial climate. And here I would protest against the statement so often made that the Southern Hemisphere is colder than the Northern Hemisphere. Darwin probably gave rise to the idea by comparing south-west South America with north-western Europe, which is warmed by the Gulf Stream. North-eastern North America almost exactly corresponds in climate with south-western South America. Newfoundland, in the same north latitude as Penas has south latitude, has a very similar climate, being also chilled by an arctic current, although it has no high mountains as nurseries for glaciers. Comparison is, however, very difficult on account of the very different distribution of land and water in the two hemispheres. If we take the corresponding north and south latitudes of 42°,

we find in the best physical atlas that the mean temperature in the depth of winter in the Northern Hemisphere varies in different places between −4° and +41°, while in the Southern Hemisphere it is about +45°. In the height of summer in the Northern Hemisphere in this latitude the temperature varies in different places between 54° and 77°, while in the Southern Hemisphere it varies very little from 59°; or, if we take the mean for the year, in the same latitude north it is 52°, and south it is 55°. As we might expect, in the Northern Hemisphere, with its great continents, the range of temperature is very great; while in the Southern Hemisphere, with but little land and vast stretches of ocean, the temperature is more equable, but at the same time it is somewhat higher on the average, and this notwithstanding the present position of the equinoctial line in the earth's orbit, which causes the summer to be shorter and the winter longer in the Southern Hemisphere than in the Northern by a few days.

The effect of cold and warm ocean-currents is well exemplified in the Northern Hemisphere by the line indicating the extreme north limit where cereals will ripen. On the east coast of North America, chilled by the arctic current, the limit is lat. 48° N.; while in north-west Europe, warmed by the Gulf Stream, the limit extends to the North Cape in lat. 72° N. On the west coast of North America, which is not chilled by an arctic current as the current flows into Behring Straits, the limit of cereals is about 58° 30′. We have no land in similar positions in the Southern Hemisphere to compare with these except in New Zealand; Stewart Island, lat. 47° S.; and Tierra del Fuego, lat. 53° S.

As regards the geological record of glacial action on an extended scale in New Zealand in geologically recent times, it is plain and abundant in the Provinces of Otago and Canterbury, and, as I am informed by Mr. McKay, as far north as the Grey River Valley on the West Coast in about lat. 42° 30′. As to the limits of glacial action on the east coast of the Middle Island, and on the question of any means we may have of judging either the duration or the date of the termination of this epoch in New Zealand, I will say nothing; but I hope we may have some valuable information on these points from Sir James Hector, Mr. McKay, and others who are experts in the geology of New Zealand.

It has occurred to me, however, as being highly probable that the peculiar surface-carving of the clay hills around Wellington may be traced to the climatic conditions of the Glacial period, when there must have been very severe winter frosts here, with heavy snowfall, and very hot summers, producing rapid thawing and violent torrents of water stream-

ing down the hillsides, and cutting out the very prominent gullies which are so characteristic of the view which we see every day as we look across the harbour, or observe the hills enclosing Wellington. That the framework of this rugged country was due to other and preceding causes there can be no doubt; but that the surface-cutting must have been the result of the erosive action of water in a much more violent form than is experienced in our existing climate seems equally certain, and I think that, although the climate in this latitude was not so severe as to allow of the formation of glaciers at the time when they were so marked a feature in the southern parts of the Middle Island, yet the winters must have been so severe as to insure a heavy snowfall throughout the long ages of the Glacial period, which has left its mark in this way by the water erosion of melting snow and heavy rains, although not by the grinding action of the consolidated snow in glaciers.

In Tasmania, evidences of extensive glaciers in former times are now found in about lat. 42° S., or nearly the same latitude as the northern limit in New Zealand. A very interesting paper on the subject, read before the Royal Society of Victoria by Mr. E. J. Dunn last year, has been kindly put into my hands by Sir James Hector. Mr. Dunn describes the district he visited near Zeehan, in the western highlands of Tasmania, which do not exceed in altitude from 1,800ft. to 3,800ft., and where the records of glaciers are left in moraines, erratic blocks, and the characteristic planing, scoring, and polishing of rocks. He observes that in the higher mountains farther south and east he is confident that still more extensive records of the last ice age will be found. He says that the appearances indicate a comparatively recent date for the glaciers which must have formerly existed in the neighbourhood which he visited.

In a paper read before the Royal Geographical Society in March, 1893, by Mr. H. O. Forbes, which has also been shown to me by Sir James Hector, Mr. Forbes refers to evidences of glaciation in South Africa as far north as lat. 27° and 30° S. I should imagine that these evidences are either on very high mountains, or that they belong to an earlier geological date than those in other parts of the Southern Hemisphere, which are not found farther north than lat. 36° S. He also refers to evidences of glacier-action in South Australia in lat. 36° S. I presume that he alludes to the ice records in St. Vincent's Gulf, near Adelaide.

Mr. R. M. Johnston, F.L.S., in a very exhaustive paper read in June last before the Royal Society of Tasmania and also furnished to me by Sir James Hector, explains these markings and erratic blocks by the stranding of icebergs on the

shore during a period of refrigeration, and by the subsequent raising of the shore to its present height of 40ft. above sea-level. This seems to be a reasonable explanation of the record of ice-action on a low shore in lat. 36° S. In this paper Mr. Johnston gives a mass of very interesting and valuable information relative to glacier-action amongst the Australian Alps in lat. 36° 30′ S. Mount Kosciusko and its neighbours, over 7,000ft. high, show evidences of former glaciers, but at high levels only. This corresponds with similar evidence in Colorado and New Mexico, in North America, where the mountains are 14,000ft. high, and formerly had extensive glaciers, reaching to about the 5,000ft. level.

In Tasmania he gives additional facts corresponding with those mentioned in Mr. Dunn's paper, showing that in recent geological times there were extensive glaciers in the western highlands of Tasmania, where the mountains are from 4,000ft. to 5,000ft. high; but there is no evidence that they reached the sea, although they have left their marks in the river-beds and on the low-lying land.

Mr. Johnston is disposed to assign a more remote antiquity to these indications than is Mr. Dunn, but Mr. Johnston is evidently influenced by the astronomical theory of Dr. Croll, and it does not appear to me that he brings any evidence to support this view, which would refer the indications of glacier-action in Australia and Tasmania, where no glaciers now exist, to 80,000 or 100,000 years ago, instead of 8,000 or 10,000 years ago as in the Northern Hemisphere.

If we inquire what were the circumstances of those parts of the earth which were affected by it during the ice age, we find these circumstances must have been very various. The most common evidences of ice-action are moraines, or the collection of boulders and stony material confusedly piled together, and often scratched and polished; erratic blocks far removed from their parent rocks; groovings, planings, and roundings-off and polishing of rocks *in situ;* in some places deep beds of tough clay mixed with scratched and rubbed stones, known as "till," in others "kettleholes" or deep hollows in the ground; long lines of deposited stones and other material, like the beds of streams, only raised in relief above the surrounding surface; and many such strange evidences of a mighty power at work, quite different from the ordinary work done by rains, and streams, and rivers, and seas, or by volcanic agency. In many instances the work has evidently been done by glaciers, as it is precisely similar to that now being carried on by existing glaciers; but where such evidences are found at a great distance from mountains—on the plains of America, Canada, central Europe, and in England—we are constrained to seek for some agency different

from ordinary glacier-action. Some geologists, who have studied the existing conditions in Greenland, believe that during the ice age a great covering of snow and ice, thousands of feet in thickness, overwhelmed wide districts in the regions where these evidences exist, and that by its agency nearly all these effects were produced in America as it accumulated and advanced, or diminished and retired. The geologists of the United States Geological Survey hold this view, and it is most ably set forth in Dr. Wright's most interesting and comprehensive book.

The Canadian geologists, with Sir William Dawson at their head, consider that there was a great submergence of the low land in the glaciated regions of North America and Canada during the ice age, and that a great part of the deposits were made by icebergs and shore-ice during this condition of things.

It seems probable that, as in most such controversies, and as, indeed, Sir William Dawson holds, both sides are partly right, and that submergence of the land and the inroad of cold currents carrying icebergs and depositing their burdens of stones and earth on the sea-bottoms, and compressing and ploughing the shores as they stranded, will account for many of the effects noticed; but they certainly will not account for all of them, and in many large districts great thicknesses of snow and ice, carrying boulders and stones and earth and other things, must have covered the hills and valleys, in the same way as Greenland is covered now, creeping outwards from the highest snow-covered land to immense distances.

In many places there is no evidence of any extensive glaciation of low lands, but only of the existence of glaciers of greater or less extent on mountain-ranges, and extending down the valleys from them, where no such glaciers now exist. Such seems to have been the case in Tasmania, and, I believe, in New Zealand; but, whatever the special results in each locality, they all alike indicate a more arctic climate where they occurred than now exists there.

The third question still demands an answer, What was the cause which produced the last ice age, and why did it cease to act?

Some geologists, and eminently Sir William Dawson, the Canadian professor, have suggested that an efficient cause may be found in those elevations and depressions of land which are well-known geological facts, and which doubtless may have had considerable climatic influence.

Sir William Dawson thinks that there is reason to suppose that during the last ice age in North America the Isthmus of Panama was submerged, and thus the Gulf Stream was not thrown northwards as at present; and also that a consider-

able part of North America was submerged; and he conceives that the greater extent of sea and the absence of the warming influence of the Gulf Stream would account for the change of climate. We have seen, however, that there is the strongest ground for believing that the warm Gulf Stream exercised the same influence on the north-western shores of Europe in the ice age as it does now; and the conditions of the Southern Hemisphere are at the present time even more favourable for the production of an ice age than those he conceives to have existed in North America during the Glacial period in regard to the distribution of land and water, yet we certainly have no approach to an ice age in the Southern Hemisphere now. We may therefore conclude, I think, that no redistribution of land and water can have been the main factor in the phenomenon.

The question, then, naturally arises, Can there have been any astronomical causes which would suffice to explain the occurrence of an ice age terminating from 7,000 to 10,000 years ago after having endured for from 12,000 to 25,000 years? Dr. Croll has attempted to give an astronomical reason, and Sir Robert Ball has lately perfected his suggestion.

I will not attempt to explain the astronomical theory as put forward by Sir Robert Ball in his most charming and interesting little book, "The Cause of an Ice Age," but merely give his conclusions, which are as follow: He shows, first, that, with the present obliquity, or approximately the same, "of the total amount of heat received from the sun on a hemisphere of the earth in the course of a year, 63 per cent. is received during the summer and 37 per cent. is received during the winter." He then goes on to show that the ellipticity of the earth's orbit round the sun varies within certain limits by disturbances caused by the other planets, and that at certain extremely long intervals this ellipticity attains its maximum. This maximum endures for a very long period, and then gradually diminishes to its minimum again. He also shows that, owing to the precession of the equinoxes, combined with a very slow motion of the major axis of the earth's orbit in an opposite direction, the line of equinoxes travels all round the ellipse in about 21,000 years. This period appears to be incorrect, and should be about 32,000 years, but in any case it is a short period compared with that occupied by the change in the ellipticity of the orbit, so that the line of equinoxes may travel round several times during a period of high eccentricity. He then explains that when during this period of high eccentricity of the orbit the line of equinoxes cuts the major axis at right angles, one hemisphere will have a very long summer (199 days) and a very short winter (166 days), while the other hemisphere will have a very short summer (166 days) and a very long winter

(199 days); yet in both cases (supposing the obliquity to remain constant) the same inequality will exist in the total amounts of heat received during summer and winter in both hemispheres—*i.e.*, 63 parts in summer and 37 parts in winter. Hence the hemisphere which was enjoying a long summer would have its heat tempered by the length of time over which it was distributed, and its short winter would have a fair amount of heat each day; but the other hemisphere would have only the same amount of heat distributed over all the days in its long winter, while its short summer would be intensely hot. Such conditions, he considers, and shows mathematically, would be very different from those now experienced on earth, and might well produce long periods of genial or arctic climate on one hemisphere and then on the other. The alternations in climate between one hemisphere and the other would, he states, each have a period of 10,500 years from commencement to end, a complete cycle lasting 21,000 years, and these cycles would probably be recurrent two or three times or more during each period of extreme eccentricity.

Dr. Croll gives the dates of these periods. The latest culminated 200,000 years ago, and ended 80,000 years ago; another culminated 750,000, another 850,000, another 250,000 years ago; and the next will occur 500,000 years hence.

Now, if we accept the geological inferences from the known facts of the last ice age in the Northern Hemisphere,—and they are so convincing that we cannot refuse our assent,—it is clear that the cause of that ice age was not the eccentricity of the earth's orbit combined with a favourable position of the line of equinoxes, whatever effect may have been produced by such a conjunction in past ages.

I will now pass on to put before you the view of Major-General Drayson, an artillery officer who has devoted the greater part of his life to the study of astronomy, and who has made a discovery which, although it has not yet met with universal recognition, is steadily making its way into the position of a fundamental astronomical fact. The discovery is this: that our earth is not only revolving daily on an imaginary axis at present inclined 23° 27′ 22·3″ to the plane of the ecliptic, or its orbit round the sun; but that it is also slowly revolving in nearly the opposite direction on another imaginary axis, the pole of which is 6° from that of the ecliptic, 29° 25′ 47″ from the pole of daily rotation, and has a right ascension of 270°, or 18 hours (Plate XLV., fig. 3). The discovery of this second rotation of the earth is fraught with most important consequences. It explains most simply the cause of the precession of the equinoxes and the varying obliquity of the ecliptic, and defines the rate of precession and the amount of the obliquity

at any date; it fixes the apparent motion of the north pole of the axis of daily rotation with accuracy, and also the corresponding motion of the south pole; it explains and enables us to calculate easily and certainly the true apparent position of every star hundreds of years ago and hundreds of years hence; and it shows us that, under the present conditions of the globe, the period required for a complete second rotation is 31,686 years (Plate XLV., fig. 4), and that during this period the obliquity of the axis of daily rotation to the axis of the plane of the ecliptic would have attained a maximum of 35° 25′ 47″ in the year 13,544 B.C. The obliquity would have been about 30° in the year 21,460 B.C., and would have returned to 30° again in 5,624 B.C. Between those dates—that is, for 15,866 years—glacial conditions, more or less accentuated, would have prevailed in both hemispheres: that is, the arctic and antarctic circles would have been brought from 12° to 6° nearer to the equator than at present, the tropical zone having been also proportionately widened, and thus much greater extremes of temperature would have been experienced, especially in what are now temperate zones. What the precise results of this great increase in the obliquity of the ecliptic would be no one probably would have been able to predict; but that such a great change in that element of the earth's position, with reference to its orbit round the sun, on which our climatic conditions mainly depend, would accomplish immense alterations in existing conditions no one can doubt. An incident recounted in General Drayson's book is so suggestive that it is worth reproducing here. He says, "Some years ago, when standing on the banks of a lake in Nova Scotia (a locality well suited to the study of the evidence of the Glacial period), I observed that the hard rocky shore was cut and marked by the glaciers and icebergs of the boulder period. In various inland localities were enormous boulders, which had been carried many miles from the parent rocks, and deposited in what was now a vast forest. My only companion was Paul, a Micmac Indian. Pointing to the boulders and the marks on the rocks I said, 'Paul, how do you account for all this?' Paul, without any hesitation, replied, 'Long time ago more winter in winter, more summer in summer. More winter make more snow, more icebergs; more summer melt snow quicker, float icebergs more than now. That what I think.'" I have no doubt that the Indian, a careful observer of the natural effects and their causes in the climatic conditions in which he lived, was right in his conclusion. There was more winter, but there was also more summer, and, as Professor Tyndall states, heat is as necessary as cold to produce glaciers and to develope their full effects. Sir Robert Ball has calculated that, with the present obliquity of the ecliptic, each hemisphere of our globe receives

during summer 62·7 per cent. and in winter 37·3 per cent. of the total heat given to that hemisphere by the sun in the year. Calculating by the same method, I find that when the obliquity is 35° the proportions are 66·5 (or two-thirds) in summer, and 33·5 (or one-third) in winter. Such an inequality would produce an exceedingly severe climate.

The period of a complete second rotation of the earth being approximately 32,000 years, and the date of the maximum obliquity of the earth's axis of daily rotation to the plane of the ecliptic being approximately 14,000 years B.C., the termination of abnormal climatic conditions occurred about 5,600 B.C., or nearly 7,500 years ago, and those conditions had endured about 16,000 years. These numbers agree with those separately and on totally distinct grounds assigned by geologists to the duration and termination of the last glacial age. It is to be noted also that General Drayson's calculations were published very many years before geologists had arrived at any distinct and comparatively unanimous opinions on the subject. Astronomically, also, General Drayson's discovery, in his mathematical deductions from it, agrees absolutely with the observations of astronomers in the past two thousand years as to the obliquity of the ecliptic, the precession of the equinoxes, and the positions then occupied by all the principal stars, and this is the best possible proof of the truth of his discovery and the soundness of his reasoning.

The steps which led to General Drayson's discovery of the second rotation of the earth—with all its far-reaching consequences—were somewhat as follow: First, he was puzzled and dissatisfied by the vague and contradictory statements made in all books on astronomy relative to a conical movement of the earth's axis without fixing the point about which it turned or the centre of the circle it described, about the precession of the equinoxes, and the variations in the obliquity of the ecliptic. He saw that it was geometrically impossible that the pole of the heavens, or the axis of the earth's daily rotation produced to the heavens, should be describing a circle round the pole of the ecliptic as a centre if this latter pole was movable, as was stated; for, if the ecliptic or plane of path of the earth round the sun was variable, the pole of this orbit must be moving also. Besides, it was not stated whether the north pole only was moving, or if the south pole was moving also, which was a very important consideration. Then it occurred to him, Why should the plane in which the earth's orbit lies be movable? Is it not much more probable that the inclination of the earth's axis of daily rotation moves? And the fact that the inclinations of the axes of rotation of the other planets vary from being nearly perpendicular to the plane of the orbit, as in the case of Jupiter, to being nearly

parallel in the case of Saturn, encouraged this idea. La Place and others had calculated that the plane of the earth's orbit could not vary more than a certain small amount,—in which they did not all agree,—but no one had discovered how much it did move, or where the pole of the ecliptic would be at any particular epoch. Nor had any one attempted to determine what effect the known movement of the zenith of the north pole of the earth has upon the zeniths of other places on the earth.

As an artillery officer he had studied the gyroscope with reference to the peculiar movements of the spinning projectiles thrown by rifled ordnance, and he knew that a rotating body, if perfectly balanced, maintained the direction of its axis perfectly in the same direction; but he also knew that a very small deviation of the centre of gravity from the centre of form produced a slow second rotation by which the direction of the axis of primary rotation was gradually altered. The question then arose in his mind, Is this what the earth is doing? Is it also slowly rotating on some other axis, so that the poles of the axis of primary rotation are each describing circles round the poles of this secondary axis? If so, the first point was to find the pole of this axis of secondary rotation. The data he had to work from were the recorded positions of a number of the principal stars, and also the position amongst the stars of the north pole at certain dates extending back for some 2,000 years—from the star catalogue of Hipparchus, dated 140 B.C., and that of Ulugh Beigh, dated 1463 A.D., down to the more complete and accurate lists of later years. He laid down the arc described by the pole of the heavens between those dates, $P^1\,P^2\,P^3$ (Plate XLV., fig. 1), and then by careful examination of the star lists he found that a certain star r had not varied its distance from the pole when the pole was at or near P^1, while other stars had varied their distances; he concluded that r was therefore in the direction of the centre of the circle of which $P^1\ P^2\ P^3$ was an arc when the pole was at P^1. Similarly, when the pole had reached P^2 and P^3 successively, he found that certain stars s and t respectively did not vary their distances from P^2 and P^3. The intersections of the lines P^1r, P^2s, P^3t, produced in the point C, showed that C was the centre, round which the pole of the northern heavens was slowly moving in a circle, and this was *not* the pole of the ecliptic, but 6° from it. Thus he obtained a sure standing-ground, and he proceeded to develope the full consequences of this brilliant and important discovery.

But first he checked his conclusion as to the true centre of the circle described by the north pole of daily rotation by means of the geometrical truth that all angles in the same

segment of a circle are equal to one another. He described the circle from the centre found as above, and saw that it passed through several well-known stars (Plate XLV., fig. 2).

Let a and b represent two such stars ; P^1, P^2, P^3, successive positions of the pole of daily rotation at intervals of, say, 1,000 years. If, then, $P\,a\,b$ be the true circle described by the pole the angles $a\,P^1\,b$, $a\,P^2\,b$, $a\,P^3\,b$, must be equal to one another, but if the stars a and b are not in the circumference of the true circle the angles will not be equal. We are not told how many trials were made, and errors found and corrected ; but at length the true centre was accurately determined, and it was found to be in the position above stated. It followed, therefore, that each of the poles of daily rotation was slowly tracing a circle in the heavens round the axis of second rotation. The time occupied in describing this arc of the circle fixed the time required for a complete second rotation, and the diameter of the circle passing through the pole of the elliptic gave the dates of the maximum and minimum obliquity and their amounts.

I will not attempt to indicate the astronomical consequences, beyond observing that they reduce to geometric and mathematical certainty what was before vague, and only defined as a conical motion of the earth's axis ; the precession of the equinoxes and the obliquity of the ecliptic, which vary in their rates and amounts continually, are determined with perfect precision hundreds of years in advance ; so also are the positions of stars for each zenith, for, as he shows, the zenith of each observatory moves by the second rotation in a special direction and at a special rate ; and it is proved that in many cases, though probably not in all, the supposed proper motions of the stars are a result of the proper motions of the zeniths of the observatories, caused by the second rotation of the earth, and that the speculations about our system rushing through space towards the constellation Hercules have a doubtful foundation in facts. As General Drayson well puts it, however accurate and powerful our telescopes and observing-instruments may be, the real instrument with which we make our astronomical observations is the earth itself, which by its motions gives us our only means of measurement, and until we know precisely what its motions are we cannot make any really accurate observations.

Enough has been said on the astronomical aspect of the discovery. From our present point of view it is chiefly important from the fact that the most rigid scrutiny has hitherto failed to detect a flaw in the process of reasoning which has led to the discovery of the earth's second rotation, and the geometrical consequences of the discovery have been proved to correspond exactly with recorded astronomical observations

in such a multitude of stars and for so long a period that it is difficult to understand how more general recognition has not been given to the discovery. I fear that there is some human feeling in the case. Unfortunately, General Drayson appears to have been somewhat embittered by this want of recognition, and in his book he devotes a good deal of space to poking sarcastic fun at the astronomers. They probably feel towards him much as the French engineers did towards the cavalry officer Montalembert, who dared to differ from the great Vauban and the teachings of the French professors of fortification, and to propose a system of his own. It was scouted and considered as rank heresy for many years; but he was right, outsider though he was, and their orthodox systems have disappeared from the modern civilized world, and have been replaced by the ideas of the cavalry officer. So, I venture to believe, will the second rotation of the earth, with all its far-reaching consequences, be universally accepted as true doctrine before many years are passed. Already the Royal Astronomical Society have tardily taken the first step by conferring the fellowship of the society on General Drayson.

With regard, however, to the geological aspect of this second rotation, it is objected that it saddles us with a succession of glacial ages at regular intervals in the past, of which we have no evidence: indeed, we have evidence of a genial climate in arctic regions immediately preceding the glacial climate, and in former periods of the world's history we have evidence of climates very equable all over the earth at certain times.

General Drayson suggests, to meet this difficulty, that a similar cause to that which probably produced the existing second rotation on an axis in its present position may under different conditions have produced a second rotation round a different axis, and, as a consequence, very different climatic conditions.

We know that at different periods in the world's history there have been very different distributions of sea and land from those which now exist. Now we have the bulk of the land in one part of the Northern Hemisphere. Supposing this special distribution to be the cause of the existing second rotation—as it well may be, small as the mass of the land above water is compared with the mass of the whole earth, for it alters the symmetry of the globe, and throws the centre of gravity some small distance out of the centre of the axis of daily rotation, and *any* such difference must inevitably cause a second rotation—admitting this cause, then, we can see that any considerable submergence of land in one place and elevation in another would alter the position of the centre of

gravity, and set up a secondary rotation on some other axis. We may suppose, for instance, that previous to the Glacial age the axis of second rotation was in some such position as C^1 (Plate XLV., fig. 5), under which conditions the pole of daily rotation would have been close to E, the pole of the ecliptic, for many thousands of years, and consequently a uniform climate, without changes from summer to winter, would have prevailed all over the globe, although of course it would have been hotter near the equator than near the poles. If, when the pole reached A at the culmination of the Glacial period, the distribution of land and water were altered to approximately what it is now, so that the pole of the axis of the second rotation were shifted to C, the movement of the pole of daily rotation would gradually diverge from the path of the smaller circle to that of the larger, which it now pursues. This suggestion of General Drayson's is merely a hypothesis, which possibly might account for the more genial climate in arctic regions which geological evidence shows to have existed previous to the Glacial age. The hypothesis would involve a shortening of the period of extreme cold by three or four thousand years. But when once we recognize the fact that any alteration in the form of the surface of the globe which moves the centre of gravity from its symmetrical position must cause a second rotation about an axis depending upon the balance of the globe at the time, we have a wide field of investigation opened to us as to the possible changes of climate which may have occurred during the past history of the globe.

In order to show that this cause of a second rotation of our globe is reasonable, we may make a rough comparison between the present conditions of the earth and those experimentally produced with a gyroscope.

The most recent estimates of the extent of land in the Northern and Southern Hemispheres at present give an excess in the former of about 23,000,000 square miles, the greater part of it lying in the eastern part of the hemisphere. Assuming $\frac{1}{10}$th of a mile, or about 500ft., as the average height of the land above the water, this would give 2,300,000 cubic miles of land. The volume of the globe is 260,000,000,000 cubic miles, and its density as a whole is about twice that of the upper strata: hence we find that about $\frac{1}{226087}$th or, say, $\frac{1}{230000}$th part of the mass of the earth projects at one point and throws it out of equipoise. Is this a sufficient cause to produce one second revolution in about 32,000 years, equivalent to $32{,}000 \times 365 = 11{,}680{,}000$ daily revolutions?

I assume the weight of a wheel of a gyroscope to be 1lb., and that it is revolving fifty times in a second, and make a comparative rule-of-three statement to find how many of these

revolutions would be required to produce a second rotation if a weight of $\frac{1}{2}$oz., or $\frac{1}{32}$nd part of the weight of the wheel, were added to one side to throw it out of balance, as compared with the $\frac{1}{230000}$th of the mass of the earth which destroys its balance and produces a second rotation in 11,680,000 revolutions; $\frac{1}{32}$ of weight of gyroscope : $\frac{1}{230000}$ of weight of earth :: 11,680,000 revolutions of earth = 1,625 revolutions of the gyroscope, or 32 seconds. That is, under the above conditions the gyroscope ought to complete a second rotation in a little over half a minute; and this is approximately what would happen. Of course the comparison is very rough, because friction interferes very greatly with the action of the gyroscope, and the mode of the attachment of the extra weight and the direction of the pull of gravity are different; the estimate also of the protuberance on the earth is very inexact: still, it is sufficient to show that the second rotation of the earth is not only a fact discovered and proved astronomically, but that an efficient cause to produce this effect exists in the present distribution of land and water on the earth. Possibly the inequality of the earth's equatorial and polar diameters (to which Herschel in his popular explanation attributed the precession of the equinoxes) may have a perturbing effect, as the inclination of the earth's axis of daily rotation to the plane of its orbit varies in its second rotation.

There is, as I have said before, a wide field for future investigation opened up by this discovery of the second rotation of the earth, and most probably it will be found that some minor corrections must be made in some of General Drayson's results, owing to perturbations resulting from other causes. But the beauty and simplicity of the secondary motion of the earth which has been brought to light by his sagacity and life-long persistent labours seem to me to rank with the highest discoveries of astronomy, and the name of Drayson will in the future stand very high in the list of the great astronomers.*

In connection with the ice age the historical nature of General Drayson's discovery is of deep importance, and, whether the great increase of the inclination of the earth's

* This discovery will no doubt produce a revolution in astronomical observatories, as the laborious observations now made year by year to ascertain the apparent motions of the stars, and so by empirical rules to calculate their apparent positions a few years in advance for the compilation of the "Nautical Almanac," have become useless. The apparent movement of each star, caused in reality by the second rotation of the earth, can now be calculated with perfect accuracy for hundreds of years in advance. A few competent men with calculating-machines can easily perform what has hitherto needed a great staff of observers with astronomical instruments, and subsequent laborious reductions of their observations. Astronomical time, also, which has hitherto needed to be fudged from time to time, will now be accurately determined.

axis of daily rotation to the plane of its orbit, which he proves to have occurred in both hemispheres for some 16,000 years, ending about 6,000 years ago, was or was not the sole efficient cause of the glacial conditions which immediately preceded the present climatic state of the earth in the Northern Hemisphere, it must have been a most important factor. Should it appear that glacial conditions were synchronous in both hemispheres, the astronomical explanation would seem to be complete.

This is really a crucial question, and I hope we may have some light thrown upon it this evening, as I suppose there are no living authorities so competent to give an opinion on the subject as some of those now present. My own imperfect observations, which have been confined to the valley of the Waitaki and to the vicinity of Lake Wakatipu, have led me to believe that the great moraines and other evidences of glaciation to be seen there are geologically very recent: indeed, owing to the slight changes made by the hand of man in this country, they have the appearance of being even more recent than similar evidences of old glacial action which I have seen in Europe, because the latter have been considerably modified in most cases by human agency. If there be no strong reasons which would lead a geologist to assign a date for the southern glaciation some 100,000 years prior to that of the glaciation in the Northern Hemisphere, the astronomical changes traced out by Sir R. Ball cannot have been effective in this matter. Indeed, his explanation throws the whole cycle of changes 80,000 to 200,000 years back, which is contrary to geological evidence in the Northern Hemisphere, with which, however, Drayson's discovery, with its consequences, is perfectly in harmony.

Should it be established on sound geological evidence that the last ice age in the Southern Hemisphere was synchronous with that in the Northern Hemisphere, the harmony between geological results and astronomical causes, as demonstrated by General Drayson, will be complete for the last ice age. Prestwich states that he has been unable to obtain any reliable evidence of glacial action in any of the formations between the Permian and the Recent; other geologists have thought they had evidence of intermediate ice ages. Possibly Sir R. Ball's theory may throw light on this question; but, as regards the last ice age, no cause that has been suggested appears to have weight or fitness compared with that resulting from General Drayson's discovery of the second rotation of the earth.

I think it was Galileo who, when objections were urged against his statement that the earth was daily revolving—not the heavens—contented himself with remarking, "E pur si muove," Nevertheless it *does* move. General Drayson may

well adopt the expression as regards the second rotation of the earth.

To sum up. It has been established by unassailable evidence that the slow movement of the prolongation of the earth's axis of daily rotation in the northern heavens, which has long been known, is the result of a slow second rotation of the earth on an axis the poles of which are 6° distant from the poles of the ecliptic, and having a right ascension of 18 hours; that this slow second rotation is the cause also of the precession of the equinoxes and the varying obliquity of the ecliptic; that this obliquity would have attained gradually to its maximum of 35° 25′ 47″ about 15,448 years ago, and then gradually declined again until the present time. About 7,524 years ago, or 5626 B.C., the period of extreme obliquity would have expired, after having endured for about 16,000 years. During that period the arctic and antarctic circles would have approached the equator from 12° to 6° nearer than at present, and consequently climatic conditions would have been greatly changed, especially in the zones south and north of the present arctic and antarctic circles. The tropical regions would also have been similarly extended. All this follows if we admit that the earth has been rotating on its second axis during this period of the past as it is now. The geological records of the Northern Hemisphere show that during this period there was an ice age in the above-mentioned zone extending farther south and being more intense in its action in some places than in others, for reasons which we can in a great measure discern. This ice age, then, we must infer was the result of the increased obliquity mainly.

In the Southern Hemisphere there are similar records of an ice age, modified by local circumstances as in the Northern Hemisphere. This ice age is also comparatively recent, and its limits correspond with those in the Northern Hemisphere. We are naturally led to suppose that its cause was the same as that in the Northern Hemisphere, and that it occurred at the same time. It remains for geologists to say, after full investigation and consideration, whether there are any reasons which are insuperable, and which oblige us to disbelieve that the great increase in the obliquity of the earth's axis which occurred in both hemispheres at this time produced the effects here which are comparable with those in the Northern Hemisphere.

Appendix A.

In consequence of what was said in the short discussion which I invited at the close of my address, I would add that, although the astronomical facts which follow from the dis-

covery of the second rotation of the earth, as to the increase of the obliquity of the earth's axis of daily rotation to the plane of the ecliptic during a period of some 16,000 years, terminating about 7,500 years ago, are in perfect accord with the geological facts in the Northern Hemisphere, yet in the Southern Hemisphere the accord is not yet so well established. The southern extremity of South America is the only land in this hemisphere in which, on account of its latitude south, we could expect to find very marked evidence of the Glacial epoch, and such imperfect acquaintance as we have with this little-known part of the world leads us to believe that in recent geological times glaciers on a large scale existed in latitudes much farther north than they are now to be found. Tasmania, in its western highlands, gives similar evidence, and even in southern Australia there are some concurrent records of lower temperature in winter than at present. In New Zealand, however, the record appears to be different, and Sir James Hector considers that any evidences of former glacial action should be referred to a much more distant date. The geology of New Zealand is very peculiar: the great faults and dislocations of strata show that in comparatively recent times great changes in level have occurred, and consequently the records of a changed climate during the ice age are very difficult to unravel; mountains which show evidences of glacial action are now at a lower level than neighbouring mountains which show no such evidences. The great sounds on the south-west coast of the Middle Island, if cut out by glaciers, would seem to require a very much longer time than 16,000 years for their excavation. We cannot therefore, at present, draw any geological support for the second rotation of the earth from New Zealand, beyond the fact that in recent times there were glaciers here where there are none now. Possibly the climatic changes due to the changes in the ellipticity of the earth's orbit ascertained by Dr. Croll and Sir Robert Ball have here left their mark. I will not pretend to be able to decipher what our most able geologists are in doubt about, and must therefore leave New Zealand outside my argument, as an exceptional and perplexing problem; but I must, nevertheless, maintain that the surface of the rest of the earth, within the limits of the extension of the arctic and antarctic regions caused by the second rotation of the earth, has undoubted records of that extension both in the Northern and Southern Hemispheres, and that in Patagonia, Tasmania, and South Australia there is no real reason for supposing that these records were not of the same date as those in the Northern Hemisphere. It seems to me that, when this is established, it will give in the Southern Hemisphere a sure point of departure in time by which we may synchronize the southern

geological epochs with those in the Northern Hemisphere, at least for some distance backwards from the date of the ice age. I need not perhaps refer to other objections raised on the grounds of discoveries in Egypt which are considered to indicate a high civilization there at a very remote date, because the ice age had little or no influence on Egypt or any tropical or subtropical countries. As far as the facts of the ice age are concerned, man may have lived for millions of years in those regions of the globe while north and south the climate would have been very unfavourable for human occupation.

It is, undoubtedly, very remarkable that none of the great astronomers of the past should have discovered, and that few of those of the present day should yet have admitted the truth of, the second rotation of the earth; but this is not the first time in the world's history that such a thing has happened. New truths are slowly accepted, especially when they are opposed to received theories which have the sanction of great names; but *magna est veritas et prævalebit.* If General Drayson's discovery be a truth, as I conceive he has proved it to be, it must be accepted in course of time.

Appendix B.

Since this address was written and delivered, I have had the advantage of reading "General Astronomy," by Professor Young, of New Jersey College, in which he explains very clearly the precession of the equinoxes on the principle of the gyroscope.

He shows (pp. 134, 135) that the attractions of the sun and moon on the parts of the equatorial protuberance of the earth which are nearer to them produce a "couple" which is equivalent to a pull on the poles of the axis of daily rotation, tending to bring the plane of the earth's equator into coincidence with the plane of the ecliptic, and that this pull, like that of a weight attached to one end of the axis of a gyroscope, results in the same effect—viz., a slow secondary rotation of the earth in the opposite direction to the diurnal rotation. He assumes, however, according to the received theory, that this second rotation is about the axis of the plane of the ecliptic. General Drayson has shown that, as a matter of fact, the second rotation is about a different axis, and he suggests that the cause is the preponderance of the Northern Hemisphere over the Southern, due to the vastly greater extent of land in the former.

On reconsidering the question in the light of Professor Young's demonstration, I see that the equatorial protuberance is largely, if not mainly, the cause of a precession of the

equinoxes. I also see that the preponderance of the Northern Hemisphere affects the question in a somewhat different way from that suggested by Major-General Drayson, and which in my address I accepted. During summer in the Northern Hemisphere the pull on the equatorial protuberance tending to bring the plane of the equator into coincidence with that of the ecliptic will be directly opposed by the extra pull on the Northern Hemisphere. During winter it will be aided, but in a lesser degree, the north pole being turned away from the sun instead of towards it. During autumn and spring the effect produced by the equatorial protuberance is reduced, becoming zero at the equinoxes. The tendency produced by the northern preponderance will be to draw the north pole towards the sun—*i.e.*, towards the north during autumn, towards the south during spring. These two tendencies, being equal, would eventually balance one another. The total result, then, must be to diminish the effect of the equatorial protuberance, and therefore to increase the time required for a complete secondary rotation or precession of the equinoxes. Whether the northern preponderance has any effect in determining the axis of the second rotation I am not prepared to say; but it seems to me probable that it has such an influence, and that variations in the direction of the axis may have taken place in past periods of the world's history, as Major-General Drayson suggests, caused by the great upheavals and submergences of land which geology records. The working-out of the problem requires the use of the highest branches of mathematics, with which I am not familiar; but it has been referred to a distinguished mathematician in England. Meanwhile, the facts of the second rotation of the earth on the axis and in the period discovered by Major-General Drayson, with all the remarkable results of the discovery, remain uncontroverted. Quite recently these facts have been verified and established by Admiral De Horsey in a totally independent and original process of investigation and calculation.

Art. LXI.—*On some Peculiar Cases of the Reflection of Light.*

By Major-General Schaw, C.B., R.E.

[*Read before the Wellington Philosophical Society, 17th October, 1894.*]

Plate XLVI.

The reflection of light from smooth water or water agitated by gentle ripples is a natural phenomenon which is familiar to to us all, whether the light be that of the sun, or moon, or a brilliant planet like Jupiter, or of artificial lights like those in a harbour or on board ships; but in all these cases we see the light as well as its reflection doubling it in the water. There are cases, however, in which we observe only the reflection, the source of the light which is reflected being hidden from us; and such cases are at first somewhat puzzling. One such case I observed about this time last year, and I have seen it again this year during calm bright weather a little before sunset. It is only in spring and autumn that the phenomenon is observable from my point of view, although doubtless it would be seen at other times of the year, when the sun sets farther north or south, from other points of view.

The window of my sitting-room in Aurora Terrace is about 180ft. above the sea, and it faces towards Clyde Quay, or south-east. When the sun is lowering towards the west, and is not visible from my window, a singular appearance of reflected light is often to be seen on the comparatively calm surface of the water towards the Te Aro Baths; and at first I was unable to trace the source or sources whence the reflection came. None of the windows of the houses on the hill-side above the water showed any bright reflection of the sun; nevertheless the reflection was due to some of these windows, as appeared evident on consideration, and as will be seen from the annexed diagrams (Plate XLVI.).

First, let us look at the course of the sun's rays as seen in section, or looked at sideways. At the time when the bright reflected patch of light was visible on the water at W from the point of observation at O, the sun was at such a height that the ray of light in the direction S H was reflected downwards to the water at W, and thence again upwards to the eye at O; the angles of incidence and reflection in both cases being of course equal. The reflection at W was repeated many times on various inclined surfaces of minute wavelets, and so produced a patch of sparkling light of some size, considerably larger than the window whence the light was reflected. The reflection of the sun from the window was not

directly visible at O, because the rays were thrown downwards to W, not in the direction towards O. The bright patch of light persisted for some minutes, notwithstanding the revolution of the earth, which causes the apparent downward movement of the setting sun, both on account of a slight dispersion of the rays reflected from the window-panes, and also and more specially on account of the varying inclinations of the reflecting surfaces of the wavelets.

But not only is it necessary that the eye should be at the right level to see the reflection, the sun also being at the right elevation to produce it, but also the position of the eye in plan with reference to the direction of the sun's rays, and the orientation of the wall of the house, a window in which acts as the first reflecting mirror. This will be seen from the plan showing the course of the sun's rays if seen from above. The position of the setting sun in spring and autumn is about as shown on the plan, and it will be evident that the window acting as the first reflector must be such that the angle it forms with the impinging ray is equal to that formed by the reflected ray which reaches O in consequence of its second reflection from the surface of the water. If the building were in any other alignment the reflected ray would be otherwise directed, and would not be seen at O.

It will be evident, also, why I only see this reflection at this time of the year or in the autumn. When the sun sets farther south in the summer, or when it sets farther north in the winter, the reflections are thrown towards the north or the south, and are not visible at O, as they are when the sun is setting in the intermediate point. But by shifting the point of observation the reflection no doubt would be seen when the sun is at the same elevation, if the point of observation were at the same level, or, rather, in the same inclined plane.

The effect is the inevitable result of the law of reflection of light from reflecting surfaces—viz., that the angles of incidence and reflection are always equal and in opposite directions; but, to see the effect, the eye, the vertical mirror (which is the window), and the sun must be in the right positions to fulfil the conditions of the law of reflection.

A much more beautiful and astonishiug effect of reflection is to be seen, however, under favourable circumstances under the steep clay escarpment of the hill on which Mr. Fitz-Gerald's house stands. This clay escarpment appears from my window to be of a uniform reddish-yellow colour, with patches of green bushes growing upon it. But when the surface of the water at the base of the cliff is not agitated by wind, and the afternoon sun is shining brightly on the cliff, the reflection in the water is coloured in the most gorgeous

manner with a beautiful intermingling of yellow, orange, red, and green, so intertwined and mingled that the effect is equally beautiful and astonishing. How comes it that the reflection of an object which seems uniform and dull in colour presents such a varied and brilliant appearance? The explanation I take to be as follows: The cliff—although, at the distance of over a mile from which it is viewed, it seems to be of a uniform and somewhat dull colour—is in reality composed of small pieces of clay, earth, and stone of very varied and comparatively pure colours. These are blended by distance into a uniform reddish-yellow; but each spot on the cliff, each coloured piece of clay or rock or green bush, is reflected in the water, and reflected not only once, but a great many times, on the numerous mirrors presented by the surfaces of the small ripples. This multiple reflection of each separate bit of colour enlarges it, and so makes that colour evident to the eye viewing the reflections from a distance, although the actual spot giving off the coloured rays which are thus repeated so frequently on the water-surface is too small to be detected by the eye at that distance.

I think that wonderfully close observer of nature, the great painter Turner, has, in one of his pictures of the Venice Lagoon, illustrated in some degree this peculiar effect of reflections from water when the surface is smooth but undulating; but I have never observed the effect so strikingly manifested as in the reflection of that clay cliff below Mr. FitzGerald's house, and I do not think that it has been generally noticed or recorded by landscape-painters.

There is to most minds a great pleasure and satisfaction in tracing effects back to their causes, even although we may be able only to take a few steps backwards, to detect a few of the last links of the long chain of causation which has brought about the result. This is all I have attempted to do on the present occasion. To do more would be to go over again, very imperfectly, the ground covered by the distinguished authors of the latest books on light (such as those of Sir George Stokes and Professor Tait), which explain the present state of our knowledge of this subject, whether actual or hypothetical, and also where even hypothetical knowledge ends and ignorance begins. I should have to attempt to answer such questions as these:—1. What is light? 2. What is the cause of the light of the sun? 3. How does this light travel from the sun to the earth? 4. What are the laws of reflection and refraction of light, and what are the causes of these laws? 5. What is the structure of the human eye? 6. How is the impression received by the eye conveyed to *me?* 7. What is *life*, which enables *me* to receive the information conveyed by light to the eye, and from it by nerves and brain to *me?*—and many other

such questions, to some of which only can comparatively satisfactory answers be given, in the present state of our knowledge—perhaps to none of them full and certain answers.

It was a very wise and happy determination on the part of Lord Salisbury to select as the subject for his most valuable address at the last meeting of the British Association scientific ignorance, rather than scientific knowledge. Not that he might discourage or check research into all the mysteries of nature; rather to stimulate and encourage it by showing what an immense extent of undiscovered country still remains to be explored; while giving at the same time a timely hint to some who seem to imagine that modern science is more perfect, homogeneous, and complete than it really is, notwithstanding the very great progress that has been made in all directions during this nineteenth century. To any of our members who have not read that address and the speeches which followed it I would venture to recommend its perusal. It was printed in the London *Times* of the 9th August last, and doubtless it has appeared in many other publications.

Art. LXII. — *The Immortality of the Cosmos; being an Attempt to show that the Theory of Dissipation of Energy is limited to Finite Portions of Space.*

By Professor Bickerton.

[*Read before the Philosophical Institute of Canterbury, 7th November, 1894.*]

The task of showing that Lord Kelvin's theory of dissipation of energy is limited in its action, that it only applies to finite portions of space, and that there are independent counteracting agencies in the cosmos taken as a whole, is one not to be lightly undertaken, seeing that the universal application of the theory is practically accepted by the entire thinking world. Nor have I thought lightly of it. The results I shall offer were worked out more than a dozen years ago, and previous to that every step had been submitted over and over again to the judgment of physicists and mathematicians during the three years of its development. I do not suggest any fallacy in Carnot's great generalization founded on his reversible engine; nor in Professor James Thomson's deduction from Carnot's work; nor in Lord Kelvin's axiom, as regards any individual body or system, that "it is impossible by means of inanimate material agency to derive mechanical

effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects." Yet I shall attempt to show that hydrogen nearly at rest may take heat from a particle of cosmic dust, and, in this way, cool it below the temperature of surrounding objects, and that this energy may take the hydrogen to positions of higher gravitation potential. Thus low-temperature heat is turned into the potential energy of gravitation. I shall also attempt to show that by inorganic means the known laws of nature are at work taking the place of Professor Clerk Maxwell's imaginary demons, who, he suggests, by sorting atoms, may elevate energy.

I do not in the least quarrel with Lord Kelvin's argument in the *Fortnightly*, in which he classifies the attempt of Hutton and Lyell to make the solar system a perpetual-motion engine as of the same order as the efforts of the humblest mechanical perpetual-motionist. Undoubtedly Lord Kelvin's views are true of the earth, of the solar system, and even of the universe. It is only in the study of the interaction of systems that the axiom is found to fail.

Of course, the great generalization of cosmic evolution, of which this paper is a part, only acquired its present form as contained in the published Synopsis after almost endless modifications; but for the past twelve years, although enlarged, it has otherwise remained practically unchanged, and, although I have in many lectures submitted its principles to the judgment of Honours scientific and mathematical university graduates, no flaw has yet been detected in the reasoning.

The practical demonstration of the accuracy of the more fundamental part of this generalization by its anticipation of many recently-discovered and complex phenomena, combined with the independent rediscovery by Dr. Johnstone Stoney, and the indorsement by the scientific world, of what I have called "selective molecular escape," confirms the confidence I have always felt in the more complex and far-reaching part of the theory of constructive impact.

The theory of the dissipation of energy as defined by Preston ("Theory of Heat") states, with respect to the energy of the universe, that "it is constantly undergoing transformations," and that "there is a constant dissipation in operation, and a constant degradation to the final unavailable form of uniformly-diffused heat."

It affirms, practically, that all the agencies of the cosmos tend to concentration of matter and diffusion of energy. In its baldest form it supposes that the cosmos was once a mass of infinitely diffused gas, and will finish by being a simple, cool body, at a temperature uniform with that of space. The

following reasoning provides the only means of escape from this dismal conclusion that has not been refuted.

If, as I consider Proctor has conclusively proved, our universe is of definite and not chance form, it must have had a definite and not chance mode of evolution; and if, as I have suggested elsewhere, its form is demonstrably similar to that resulting from the partial collision of two previously-existing universes, we have a right to postulate the existence of universes other than our own; and late photographic observations suggest, at least, that we have such universes actually within sight in the shape of the Magellanic Clouds.

If light suffers extinction in travelling long distances, as Struvé's observations suggest to be the case, and as seems reasonable considering the dusty condition of space, then the number of unseen universes may be infinite.

In disproving the theory of dissipation as applied to the whole cosmos, we do not have to prove the immortality of the cosmos, but only to demonstrate the possibility of its immortality. The idea that the process of cosmic evolution is finite in time is so essentially repugnant to most minds that it is only after the most diligent search for and the failure to show the possibility of the contrary that the dissipation theory has been accepted. Rankine, Clausius, and other great physicists have attempted to remove it; but their reasoning has been shown to be faulty. It is easy also to show that Herbert Spencer's attempt in his "First Principles" fails on grounds of equivalent energy.

If space is dusty, radiation may all be caught by matter, thus raising its mean temperature, and so it is possible that no radiation is wasted, but that it all falls upon the meteoric and other matter of space. The idea that space is thus occupied throughout with gaseous molecules and solid meteoric and other dust is common to many hypotheses. Some sixteen years ago I demonstrated, and Dr. Johnstone Stoney has recently shown, that there is a tendency for light molecules, such as hydrogen, to obtain velocities high enough to enable them to escape from gravitating masses. I have shown this to be the case particularly during impacts, when molecular escape would probably be, on the average, very considerable. Again, the coalescence of free heavy gaseous molecules escaping from dissipating bodies, together with impacts between comparatively small bodies, tends to besprinkle space with solid matter in the form of dust. The formation of such free solid matter is discussed in my Synopsis under the head of "The Formation of Star-clusters and Meteoric Swarms."

When moving bodies, molecular or otherwise, are not in closed orbits they remain but a short time at high velocities. The highly hyperbolic orbit of a comet in its journey round

the sun is a characteristic instance of this. The comet is a few days near the sun at high velocity, then it remains for longer and longer periods at lessened velocity, getting slower and slower, until it is beyond the sun's effective gravitation. Therefore gaseous molecules distant from gravitation, as a rule, are moving slowly. But slowly-moving gas is cold,—colder than the solid dust of space,—and any of this gas coming in contact with cosmic dust will be warmed by this dust, and, heat being molecular motion, will bound off with renewed velocity, to be again exhausted only (in the absence of contact with other matter) by doing work against gravitation, and so passing to rarer portions of space, where potential energy is higher, finally moving slowest of all where there is least matter.

In the case of bodies moving indiscriminately, where motion is slowest, they tend to aggregate. If over a plain all persons walked in indiscriminate directions at four miles per hour, except within a certain area where they walked one mile per hour, there would be on the average four times as many persons in equal areas within that space as elsewhere. So in cosmic space this diffused gas will move slowest, and tend to aggregate in the bare parts of the cosmos. Thus, to summarize: Radiant energy falling on the dust of space is converted into diffused heat, the lowest form of energy, and this is transferred to free light molecules, increasing their velocity, and this motion is converted into the potential energy of gravitation, the highest form of energy. At one and the same time, in opposition to the theory of the dissipation of energy, there is a tendency to disperse matter and raise energy.

Were hydrogen and other light molecules plentiful enough, obviously this action would not cease until the rare parts of space were as well filled with these light molecules as the rest of space with other matter. There is no necessity, however, to assume this enormous amount of hydrogen as far as the purpose of this theory is concerned, for after a time another action sets in. Where matter is aggregated into condensed masses, as in our universe, free bodies such as comets, or stars of 1830 Groombridge type, pass through and escape from them; but this is not the case in a mass of diffused gas, the retarding friction of which tends to stop all such wandering bodies entering it. Thus the sparse portions of space, once filled with diffused hydrogen, become traps to catch indiscriminately-travelling matter. So after a time accumulation goes on, not because molecules come to partial rest there, but because of the gathering action of the friction of diffused gas, and coalescence sets in, due to the presence of these trapped stars. As radiation from these bodies permits condensation, a new universe begins to form

in what was the rarest part of space; so that an action is constantly going on tending to balance the distribution of matter in space, whilst the action of gravitation is as constantly tending to unequal distribution.

It may be asked, How can matter ever escape such a universe again? Two or three methods suggest themselves, and there are probably others. Firstly, contact with hot bodies having no atmosphere would give the gaseous matter an escaping velocity. Secondly, any bodies coming into impact would tend to lose their hydrogen through the phenomena known as "selective escape." Thirdly, three bodies passing near each other may give one of them an escaping velocity at the expense of the other two. Universes formed in this way by aggregation in the rare parts of space may be called universes of the first order; whilst universes such as the one of which our solar system forms a part — universes obviously made up of the coalescence of two impacting universes—may be called universes of the second order. If a universe formed by the coalescence of two similar universes necessarily contained more matter than one of the original universes, when the coalesced universe had condensed to its size a process of aggregation would be going on in the cosmos that would ultimately lead to the increase of the masses of universes, and the cosmic process would not be strictly rhythmic.

I have already suggested three agencies, in universes of the first order, by which matter may pass out of universes. In addition to these it can be shown that, during the ages of coalescence and subsequent expansion of the system, there are many agencies that will send matter out of the system.

Taken altogether there seems reason to suppose that sometimes the collision of universes may make three of two, sometimes make one of less mass than either of the two original universes, and sometimes one of greater mass than either. But the agencies are of such complexity and variety that they would simply overload this statement of the possibility of an immortal cosmos. The most important agency to consider is the approach of three bodies. This may gradually use up the chief energy of a system in sending bodies out of the system. As is well known, whenever three bodies pass near each other, one at least has its velocity increased at the expense of the other two. It may so happen amongst the members of a system that one has its velocity so increased as to actually escape the attractive power of the system itself, and become a free wanderer, as 1830 Groombridge is believed to be in our universe. No matter how rare an event this may be; only give time enough, and most of the energy of motion must be used up in thus causing the escape of bodies. For we must remember, if once, in a thousand chance approaches,

a body attains sufficient velocity to escape, when it has that velocity it is gone for ever, so that ultimately most of the remaining energy of a system of indiscriminately - moving bodies will be used up in giving an escaping proper motion to some of its members.

Think of an analogy. The energy of the attraction of potassium for oxygen is enormous compared with the affinity of carbon for oxygen. But carbon is a fixed substance, as also is carbonate of potash. When, by the most extraordinary coincidence of abnormal velocities, carbon succeeds in dislodging potassium and taking up its oxygen, both the substances form gases, and they at once escape the influence of their affinities; and so this most remarkable fact occurs: that carbon is capable of reducing potassium from its compounds. So with the escaping bodies from a system: give them time enough, and they must go as long as there is energy enough to send them.

Nor must we forget that, as a universe contracts, its potential energy is slowly turned into motion, so that the mean velocity of stars will become much greater. They would be closer together, and the number of their approaches and encounters more and more frequent, tending all the time to disperse matter. Taken altogether there seems to be an abundance of agencies from the time of impact and coalescence of the original universes to the time of the concentration of this new universe for the dispersal of one-half of the original mass; so that at the final state of the universe its mass will be no greater than that of one of the universes from which it was formed.

The series of these agencies are as follow:—

1. Diffusion of heat by radiation.
2. Heating of cosmic dust by radiation.
3. The heat of cosmic dust taken away by slowly-moving hydrogen molecules.
4. Free hydrogen will remain longest where its motion is least, and will aggregate in the empty parts of space.
5. It then becomes a trap for wandering bodies, that tend to be stopped and converted into dense nebulæ.
6. These dense nebulæ tend to attract surrounding gas; they cool and shrink, ultimately forming solid bodies.
7. These solid bodies, by mutual attraction, give form to the new universe.
8. Such universes are of the first order.
9. The impact of universes of the first order produces universes of the same type as our own.
10. The coalescence of two universes does not necessarily result finally in a universe of larger mass than either of the

two, as many agencies tend to send matter out of the coalescing mass.

Thus, in contradistinction to the theory of dissipation of energy, there appears to be no evidence to show that the cosmos as a whole is other than immortal. The great Creator, when He launched the infinite, did not do His work blunderingly, but gave us a system equally perfect, whether it be in the marvellous forces within the minutest atom, the complex structure of organic molecular groupings, the infinity of cosmic dimensions, or the eternity of cosmic duration. There is no flaw in the perfection of the vast design. Atoms clash, combine, and form molecules; and these break up again. Organisms are born and die. Worlds, systems, and universes are evolved, play their part, disintegrate, and disperse, only to be born again in new and complex systems. But the mighty cosmos remains ever rhythmic in its giant energies. Man's mind reels on the brink of the unfathomable as he tries to grasp the mystery even of his own being. Everything around him forces on his mind a feeling of profound humility at his insignificance. At the same time also his surroundings force upon him the most absolute faith in the perfection of the whole creation of which he is so minute a part. In the contemplation of this perfection does not one feel certain that the present disorder and misery of the world is merely that short paroxysm of apparent chaos from which order will evolve? Is it credible that the evolution of mental power, that has enabled man to pierce so far the superb grandeur of the infinite,—has enabled him to harness the forces of nature to serve his needs,—shall suddenly cease? Is it to be conceived that man will remain content to see supine indifference and selfishness destroy all that is lovely in life? It is incredible. We have but a glimpse of the eternal, but in that glimpse we see such marvellous perfection of action that we cannot fail to feel that if the same profound thought, the same unbiassed judgment, be brought to bear on the tangled affairs of human life they may be as fully unravelled as is the complex mechanism of the cosmos. May it not be that, just as the burnt child dreads the fire, so the awful effect of the selfishness that has produced the present misery amongst humanity may burn its lesson so deeply into the mind as to be inefface able in human history? It appears clear that, as Nordau has pointed out, pleasurable emotion alone can be persistent, and pain and misery are indications of those that are decadent. If this be so, what a marvellous gospel of hope is contained in the religion of science! If the so-called unpractical theory of cosmogony should only so awaken human intelligence that mankind sees clearly the perfection of the method of evolution, and acts upon the lesson, such unpractical theories will prove

themselves to be the agents that will give more joy than most of the results of commerce or business, or any of the material achievements so lauded by practical men. When the perfection of the cosmos is realized, joy will be seen to be the true lot of man, whilst pain and misery will only be suffered long enough to ascertain the alterations in our mode of life that are necessary for their removal.

Art. LXIII.—*Synoptic Statement of the Principles and Phenomena of Cosmic Impact: prepared for the Criticism of Scientific Men and Societies.*

By Professor Bickerton.

[*Read before the Philosophical Institute of Canterbury, 7th November, 1894.*]

1. The new photographic charts have demonstrated that there are over a hundred million bright stars in the Milky Way.

2. The companion of Sirius and the dark component of Algol prove the existence of dead suns. These are possibly very numerous. Sir Robert Ball thinks them more numerous than luminous ones: for other theoretical reasons I believe him to be right.

3. Stars have an independent velocity or proper motion of about ten miles a second upon an average. Recent spectroscopic observations seem to suggest a slightly higher velocity than this.

4. This motion is apparently without much order. It will alter the relative distance of stars, and may bring them near each other, and possibly into impact.

5. If they are brought near each other their mutual attraction will alter their velocity, and curve their courses into hyperbolic orbits. If they do not graze they will ultimately again attain their original proper motion.

6. When stars are very near each other their attraction will cause them to be distorted into an egg-shape.

7. The tendency to collision will therefore be increased by their mutual attraction in these two ways, for it will cause them (1) to curve their courses, (2) to be distorted when very near each other. The chances of collision will thereby be made one hundred times greater on an average. In the case of two such bodies as our sun the chances of collision would be one thousand times greater.

8. All impacts brought about in this way by deflection will be of a grazing character; consequently nearly all stellar collisions will be of a grazing character.

9. The average velocity of stars at impact will be hundreds of miles a second, and in many cases thousands. The average "proper motion" will not appreciably affect the final velocity. Thus a proper motion of ten miles will only add one mile a second to a colliding velocity (velocity acquired by attraction) of one hundred miles a second.

10. A mere graze of the atmospheres of stars obviously will not cause them to coalesce, nor will a slight graze of the stars themselves. As a mean result, when more than a third of each of two equal bodies collide, coalescence will ensue, but this will depend on the original proper motion. Were nine-tenths of 1830 Groombridge to collide with a similar star the remaining tenth would not be stopped in its course; it would pass on in space, the bulk of the two stars temporarily coalescing and then dissipating into space.

11. The effect of the collision will be to intensely heat the colliding parts.

Partial Impact.

12. The heating effect of a graze of two stars, of two star-clusters, or of two nebulæ, or even of a star plunging through a star-cluster, will not appreciably extend to the parts not colliding. To emphasize this fact such impacts have been called "partial."

13. "Partial impacts" generally result in the formation of three bodies. The fraction of each star, lying in the path of the other, which actually collides, and whose momentum will be nearly or quite destroyed, will be cut off from the rest of the star; they will coalesce and remain behind, whilst the two cut stars pass on in space.

14. Partial impacts of a third of two equal stars having considerable original proper motion would make of the two impacting orbs three equal bodies: two of them would travel on in space in opposite directions; the third would merely revolve without any motion of translation. If there had been no proper motion the three bodies would have coalesced. If less than a third be cut off from each, the two bodies become three bodies orbitally connected.

15. The temperature produced by an impact depends on the velocity destroyed and on the chemical constitution of the colliding bodies. High velocities and heavy molecules both tend to produce high temperatures. Consequently the temperature depends upon the velocity destroyed and on the molecular constitution, and not upon the amount of the graze. Were one-tenth or one-hundredth grazed off the impacting

stars, the temperature of the coalesced part would be the same.

16. Although the temperature will be the same, the gravitating power of the coalesced part will depend upon the mass and size of that part; it will increase as the mass increases, and diminish as the size increases, the mass remaining constant.

17. Heat is molecular motion. In a small graze of any given pair of stars the molecules will have the same velocity as in a large graze, but the gravitating force holding the bodies together will be different. In a large graze the body may be stable, the velocity not overcoming the attraction of gravitation; in a small graze the body will expand indefinitely in consequence of the small attractive power of the coalesced mass, and every expanding particle will have so high a velocity that it will in general become an independent wanderer in space. Consequently space will be spread with free molecules.

New Stars and Planetary Nebulæ.

18. The mass of gas produced by such an impact will obviously expand temporarily into a hollow shell of gas. Herschel tells us this is the condition of planetary nebulæ.

19. A partial impact of stars will therefore generally produce in less than an hour an intensely heated body that will expand enormously without, for a time, much diminution of heat. It will consequently become very bright indeed, and will continue to expand with diminishing intensity until it becomes a planetary nebula, and will then disappear by dissipating completely into space.

20. That is, a new star has been born that increases in intensity until the general parallelism of motion of the molecules causes a lessening number of impacts between the molecules. As molecules only radiate immediately after encounters, the luminosity will diminish, and will go on diminishing until it disappears. In special cases the planetary nebula may be fairly permanent. In other cases a permanent star may appear in the centre of the nebula.

21. The molecules on the far side of the nebula (or third body formed by the two colliding stars) will be retreating from us; those on the near side will be advancing towards us. The spectrum of such a body will consequently be crossed by broad bright bands with a maximum in the centre and gradually dying imperceptibly away. If this body has any motion in space, as it probably will have when the two colliding stars are unequal, the line of maximum intensity, though in the centre of the band, may be displaced from its true position.

Molecular Selective Escape.

22. Immediately after the impact the temperature of different kinds of molecules will be very different from one another. Were the two colliding spheres composed of oxygen, they would be sixteen times as hot as if they were similar spheres of hydrogen. The temperature at impact will be proportional to the atomic weight. In a sphere of mixed elements these inequalities of temperature would quickly equalize themselves. When this was the case the hydrogen would be moving four times as fast as the oxygen. The velocities would vary inversely as the square root of the atomic weights.

23. This difference of velocity will tend to sort the molecules into layers like those of a lily bulb. The hydrogen on the outside will be followed by lithium and other elements in the order of their atomic weights.

24. If there are elements lighter than hydrogen, as spectroscopic observations of the corona suggest, these will, of course, precede hydrogen. In my lectures and papers on this subject I have called this action "molecular selective escape."

25. Space will be thickly spread with free molecules of the lightest elements. This fact is important: it is one of the counteracting agencies that prevent the theory of the dissipation of energy being of cosmic application.

26. A telescopic view of a new planetary nebula produced by a partial impact, if seen through a prism, should give a series of discs of diameters diminishing with increase of atomic weight in its component elements.

27. This fact, taken in conjunction with the broadening of the lines into bands, will enable us to calculate the distance of such a body. It is possible, however, that the parallelism of the motion of the foremost molecules may prevent encounters; hence this layer of gas may not be luminous.

Formation of Star-clusters and Meteoric Swarms.

28. The hydrogen will rob the heavy molecules of their energy: hence in any considerable graze the heavy metals might not indefinitely expand. They would lose their velocity by radiation and by doing work against gravitation, and they would be attracted back again, and may form a star in the centre of the nebula. Some nebulæ have such stars.

29. In a partial impact the coalesced part will not have all its motion converted into heat. The momentum on the two sides will not be exactly balanced. The body will consequently tend to spin. It is generic of partial impact that it tends to cause rotation in all the bodies produced, and also that the rotation is all in the same direction.

30. It is a peculiarity of oxygen that it tends to render its compounds with metals less volatile than are the metals themselves. Almost all oxides are less volatile than the metals forming them. Consequently, when metallic atoms and oxygen come together, they produce molecules that tend to coalesce. Thus nuclei form in a nebula and it becomes dusty. If the nebula be rotating this dust tends to move in orbits, and it would be constantly picking up other dust and molecules. Thus a rotating metallic nebula, in which molecular selective escape has dissipated the light molecules, tends to aggregate, not necessarily into a single body, but oftener into a number of bodies orbitally connected. If the mass be large it will become a star-cluster, if small a meteoric swarm.

31. In star-clusters impacts should be frequent. These groups should be photographically observed to notice any sudden increase of intensity. Then the pair of impacting stars should be watched for nebulæ and for variability.

Comets.

32. Meteoric swarms when near the sun would be distorted, and the constituent fragments would impact with extraordinary frequency. They would therefore become very brilliant, and show as comets. The friction would produce an enormous development of electricity.

33. It is certain that the material of a tail of a comet does not belong to the comet itself. It is the dust of space lit up in some way like motes in air illuminated by a search-light. The phenomenon of the tail is almost certainly electrical. In a paper "On a New Relation between Heat and Electricity" I have discussed agencies that may explain the phenomenon.

34. Such a swarm, when close to the sun, would have its near part drawn in advance of, and its distant part left in the rear of, the general swarm. Its weak attractive power would cause it to separate into a train.

The above are some of the phenomena that may ensue in the coalesced mass.

Variable Stars.

35. The two stars that grazed would have a part cut out of each: this would expose the probably hot interior. Each star would entangle a portion of the other. This would increase the temperature and luminosity of the cut part of each.

36. The stars after collision would recover their sphericity chiefly by the molten interior welling up. This by momentum would overfill the space, and there would be a rhythmic tidal action, the molten lake overfilling and then sinking.

37. The retardation of the sheared stars by the entangled material would cause them to spin. This would act chiefly

on the outer layers; the inside would tend to retain the original rotation of the star.

38. Thus in the sheared stars there are three tendencies struggling with one another—(1) the original rotation, (2) the new rotation, (3) the tidal action.

39. But the new rotation would be a large component. We have therefore a star which rotates and shows us alternately its hot and cool sides. The old rotation and the tidal motion produce other fluctuations of intensity, and also inequalities of the rate of motion.

40. Evidently such a body as described would be a variable star, and for a time such stars would be in pairs.

41. Many variable stars are in pairs. It is so striking a phenomenon that the probability is one hundred sextillions to one against its being the result of chance.

42. Conduction, convection, tidal motion, and the contending rotations will tend to bring about equality of temperature. This condition of variability will consequently be a temporary one. The star will ultimately become of uniform luminosity. These are all of them known peculiarities of variable stars.

43. Convection is due to difference of density. This difference may result from differences of temperature, or of chemical composition, or of both. The lake of fire in the sheared star will consist of heavier molecules than the remaining surface, and it will also be at a higher temperature. These two will tend to neutralize each other; so that equality of temperature due to convection will not be brought about quickly.

44. Therefore, although such variable stars will doubtlessly become uniform, it is surprising what a number of agencies there are tending to retain this inequality of temperature. On theoretical grounds it appears that this condition of unequal heating may, as an extreme case, last thousands of years.

Double Stars.

45. The work of cutting the stars will be infinitesimal in relation to their available energy before collision. It will not cause any appreciable lessening of the velocity of the escaping stars. But the middle body will exert a powerful attraction. It will exercise a retarding influence, preventing the retreat of the two bodies, equal to that of three times the mass either body loses. Hence, when two bodies lose a third each by impact, they do not as a rule become free from the new central body.

46. If, however, the original proper motion were large, and the graze small, the two stars would escape each other. If the original motion were small, and the graze on an average

more than a tenth, then the two stars would become orbitally connected.

47. Such a pair, when thus connected, would form a permanent double star. It is the opinion of Proctor and other astronomers that impacting stars becoming orbitally connected could not make double stars, as they think such stars would impact again. But they overlook the fact that the nebula that retarded their escape and formed an important factor after the first impact, will have dissipated before they return.

48. Hence the eccentricity will lessen greatly, and, as a rule, instead of impacting again they will be scores of millions of miles away at perihelion. In fact, they will have about the eccentricity that double stars are known to have.

49. There is a possibility of a second impact when the graze has been a very small fraction, or if one of the stars were multiple. But the period of the subsequent recurrence of impacts, after the first recurrence, would lessen in point of time. On calculating the dates of the apparently recurrent star, "The Pilgrim," viz., 945, 1264, and 1572, this is proved to be the case. The dark bodies producing these impacts must be of absolutely stupendous dimensions. The dark bodies producing Nova Aurigæ were probably 8,000 and 4,000 times the mass of the sun respectively.

50. Double stars should be more often variable than single stars. Struvé has proved that they are hundreds of thousands of times more variable than ordinary stars.

51. We should expect them also to be more frequently coloured. This, too, is most strikingly the case.

52. We should look for them to be associated with nebulæ. Herschel says the association of nebulæ and double stars is most truly remarkable.

53. They should be highly eccentric. This is also well known to be the case.

54. A large number of agencies tend to render the orbit less eccentric. These are fully discussed in my papers of 1880.

NEBULÆ.

55. If stars come into partial impact, the tendency to form definite nebulæ, other than planetary or cometic, seems to be entirely destroyed by the outrush of the high-velocity gas. This is not the case with the impact of nebulæ.

56. Impact may take place between nebulæ, between star-clusters, between meteoric swarms, and between any two similar or dissimilar celestial bodies. The graze may be little or large; the original bodies may have had a small or great proper motion; and all these peculiarities will tend to vary the results.

57. If two nebulæ come into a slight grazing impact there will result a double nebula, which will show a spindle at the centre. As they are parting company they may have temporarily a dumb-bell appearance; but, as the two sides of the coalesced nebula are moving in opposite directions, a spiral begins to form at the centre. As the ends travel on in space the spiral would increase, and ultimately a double spiral would result.

58. One or both of the original nebulæ may be entangled in the spiral.

59. If the impact be considerable, the two nebulæ do not escape each other, and an annular nebula results. It would have gauze-like masses of nebulæ at the poles of the ring, produced by the outrush of gas during the impact.

60. There are nebulæ corresponding to every one of these conditions: nebulæ coming into impact — some in impact with the spindle showing between them; there are also spindle nebulæ left alone; others with an incipient spiral visible at the centre; others where the spiral is more distinctly visible; and others where the double spiral is fully developed.

61. Finally there are annular nebulæ with the gauze-like caps referred to above. Thus at one and the same time the evolution of nebulæ at any of its stages may be watched, and not unlikely older drawings may show the less advanced stages of the same nebulæ.

The Origin of the Galactic Universe.

62. If two universes such as the Magellanic Clouds come into grazing impact, an annular universe will result, the poles of which will be covered with nebulous matter owing to the outrush of gas during the millions of years of the impact.

63. This principle of outrush needs some explanation. As two globular masses close in upon each other, the motion will lie chiefly in a plane which might be called the orbital plane. It is obvious that the pressure of the heated gas resulting from the impact, as the bodies close the gas in, can find no escape in this orbital plane, but can only escape upwards and downwards.

64. Stars will pass into such caps of nebula as originally covered the galactic poles, and will there be entrapped, and will attract nebulous matter. They will thus become nebulous stars; or they may be volatilized altogether and become globular nebulæ. Such a distribution of nebulæ exactly corresponds with our universe.

65. Where globular nebulæ are thick we should expect double, spindle, and spiral nebulæ. These nebulæ are actually found amongst the nebulæ at the polar caps of the Milky Way. Again, where stars are thick we should expect planetary

nebulæ, double, temporary, and variable stars, and star-clusters —all the result of the impact of stars. These, as the theory requires, are almost entirely found within the Milky Way.

66. If the universe were formed by such a graze as we describe we should expect a greater density of stars in those parts of space where their motion chiefly directs the two original universes. Proctor speaks of two such clustering masses as striking features of our universe.

67. If the universe were the result of impact there would be much community of motion in adjacent stars. This is a remarkable peculiarity of the stars in the Galactic Ring. A large number of further coincidences are debated in my papers "On the Visible Universe."

The Solar System.

68. Nebulæ must tend to entrap bodies passing through them. Such bodies would frequently become orbitally connected with the nebula. Then, when the nebula, with these bodies, became a sun, it would produce a system with planets in all azimuths, in the same way as the comets that our solar system has entrapped are in all azimuths.

69. Were a sun to impact with such a body or with a dense star-cluster, and were the graze considerable, all the planets would be whirled roughly into one plane, and the central mass would become a bun-shaped nebula.

70. It is not improbable that our sun was formed by an incipient star-cluster impacting with a nebulous sun, and that the present solar system constitutes a large part of the whole impacting mass. In other words, it is probable that there was not a large ratio of the original bodies dissipated into space during the impact, but it is probable that the impact was a large-ratio collision.

71. It is to be supposed that in every impact much matter will leave the system. Some of the gas extruded by the pressure acting along the axis will be lost, with much of the hydrogen. The attraction, therefore, on the return of the planets may be so much lessened by these losses that the orbits may be converted into an approximation to a circle. The nebula would expand enormously; all the matter of it that might pass outside aphelion distance would not aid in attracting the planet back. Perihelion distance would thus be increased by this agency.

72. Of course, at first the rotation on their axes of the new-constituted planets would be in all possible directions. Thus, the axes may be in the ecliptic, or the motion may be retrograde. The order observed in the rotation of the inner planets will be established afterwards, the outer planets largely escaping these agencies.

73. Gaseous adhesion and many other agencies are at work to cause apsides to rotate. Consequently the larger nebular planets would gradually pick up all matter within the limits of their orbits, thus giving the rough order to the distance of the planets that is commonly known as Bode's law.

74. In a rotary nebula I have shown that much matter will tend to become meteoric. The absorption by a planet of every meteorite will tend to cause the planet to rotate in the common direction of the nebula, and will cause the axis to tend to become upright on the axial plane. This action will tell most with planets near the centre of the series, such as Jupiter and Saturn, because they will be largely gaseous and in the thick of the meteoric matter. The outer planets will necessarily be almost beyond the region of such influence, while the near ones will have but slight entrapping atmospheres, as explained hereafter.

75. All this exactly accords with the actual inclinations of the axes of the respective planets.

76. It is probable that the orbits of the planets were originally much smaller; but much of the potential energy of dimension would, as they shrank, be converted into energy of rotation, and this, by tidal action, into increased distance from the sun. The same may also be true of the moons.

77. As the volume of the nebula diminished its temperature would increase. An increased temperature would produce molecular exchanges between the planets and the nebula, and this would most affect the nearer bodies. Thus the near planets would lose all their light atoms by their escape into the surrounding nebula; whilst, on the other hand, the low velocity of the heavy molecules of the nebula would allow these molecules to be picked up by the planets.

78. Hence the near or inner planets would be small and dense, as we find them in our solar system, and the outer planets large and less dense, as in reality they are.

79. The heat of the contracting nebula will tend to increase the temperature of the planets, which would consequently expand. This would lessen their hold upon their light matter in two ways: (1) by the lessened attraction produced by expansion, and (2) by the increased velocity of the molecules themselves. The near planets would consequently be composed almost wholly of the heavy metals. The smaller and hotter any planets were the greater would be their chance of being without atmosphere. The absence of this and the small volume of the planets would lessen their trapping action. Consequently they would not be so upright in their orbital planes as the middle planets.

80. The distant planets, being almost out of the nebula, would not collect an appreciable quantity of matter; hence

the original axes of rotation may be at any angle, or even retrograde, as, in fact, they are.

81. As the nebula shrank within the orbits of the planets, the planets would again pick up light molecules that would form an atmosphere; but the temperature of the planets would not allow of much hydrogen being picked up unless it were in combination.

82. The resistance and contraction of the central nebula would clear space of all meteoric dust unless such were orbitally connected with a planet. The asteroids are probably parts of an exploded planet. The impact of a rapidly-moving body plunging into a planet could easily blow it to pieces. It has been suggested that, if so, such bodies would pass through the common point of their explosion. This idea is an error.

83. The trapping of their moons by the planets would probably occur when the planets were nebulous, and before the central nebula had attained to any great density. Hence they would lie roughly on the planet's equatorial plane.

84. Whilst a body of the mass of the earth could pick up an atmosphere, the smaller attractive power of the moon would not allow this at the temperature it would be at when its nebula contracted within its orbit. The moon would probably be much nearer the earth at first, but the stopping of its rotation by tidal action would increase the distance.

85. Many other agencies that would convert the system under discussion into one similar to our own are treated of in my paper on "Causes tending to lessen the Eccentricity of Planetary Orbits."

MATHEMATICAL CONDITIONS OF THE FORMATION OF NEBULÆ.

86. It can be shown, if two gaseous suns impact completely, having no original proper motion, that were the whole of the motion converted into heat, and this heat into the potential energy of expansion, then the new sun would have a diameter the sum of the diameters of the original suns. It can also be shown that such a condition is one of stable equilibrium.

87. Consequently the complete impact of two gaseous suns not possessing much original motion, and brought together by gravitation, does not make a nebula of them; but as soon as the paroxysm of the encounter is over they are of the same temperature as before, having used up all their energy in increasing to the sum of their original diameters. This is a remarkable and unexpected result.

88. Were there great original proper motion, they might become a nebula by complete impact; but were the original velocity of the two bodies very high, and the impact of very great energy, then an indefinitely-diffused nebula would result. Such a nebula, if hot, would be unstable, and would indefinitely

expand. Croll's theory to account for an increase in the age of the sun's heat is therefore untenable.

The Cosmos possibly Immortal.

89. If our universe be proved, from its configuration and character, to have been formed of two previously-existing universes, as appears probable from 59 *et seqq.*, then the entire cosmos may be made up of an infinity of universes.

90. Meteoric swarms prove space to be dusty with wandering dark bodies, and "molecular selective escape" proves it also to be spread with countless myriads of molecules of light gas. It is probably due to the dust of space that we see no distant universes other than the Magellanic Clouds.

91. If this be the case, radiation must all be caught by the dust of space, and, unless some agency be found to take this heat away, the dust must be gradually increasing in temperature.

92. Bodies not in closed orbits when moving at high velocities take but a short time to pass over great distances; they take longer and longer periods as the velocity is reduced. Hence hydrogen gas, when it has travelled into positions comparatively free from the influence of matter, will be generally moving slowly. But slowly-moving gas is cold: hence hydrogen gas may be at a lower temperature than any other matter in space.

93. Whenever by their mutual motions hydrogen strikes cosmic dust, it will acquire the temperature of the latter: that is, it will increase its molecular velocity. It will thus have a new start of motion.

94. It is evident that unless it strikes something the molecule can only lose this motion by radiation and by doing work. When it has done work, it will be further from matter, or in a position of higher potential, and Crookes's experiments prove that molecules do not radiate in free path except immediately after encounters.

95. Moving matter not in orbits will tend to move slowest where there is least matter—that is, where gravitation potential is highest—because in these places it has done most work against gravitation. Where bodies moving indiscriminately move slowest they obviously tend to aggregate: in other words the hydrogen of space tends to accumulate in the sparsest portions of space.

96. Thus radiant energy falls upon the dust of space and heats it. This heat gives motion to hydrogen, and the hydrogen then tends to use its new energy to pass to positions of high potential, thus converting low-temperature heat—that is, dissipated energy—into potential energy of gravitation—that is, into the highest form of available energy.

97. This action will tend to go on until attraction is equal in different parts of space. Thus we should have, if there were no counteracting influence, in one part of space bodies in mass, in another part diffused hydrogen.

98. But long before this equality of distribution can ensue another action is set up. The mass of hydrogen will become a retarding trap to indiscriminately-moving bodies.

99. Free bodies moving indiscriminately will tend to pass through a group of masses similar to our universe, through which 1830 Groombridge is passing now. But they will tend to be trapped in any mass of hydrogen they encounter. Thus the place that was most void of matter now begins to have more than a regular distribution of matter. A new universe of the first order has begun to form.

100. The Magellanic Clouds are probably universes of the first order. Our universe was probably formed from the impact of two other universes, and hence has a greater definiteness of configuration.

101. Mutual gravitation between the entrapped bodies would tend to concentrate the diffused mass. The new universe would be taking form.

102. When three bodies pass near each other, one at least has its velocity increased. In this way it is possible to account for the enormous velocity of 1830 Groombridge, although this high velocity might also be due to the attraction of our universe, or of a near dead sun, the truth of which latter idea could be ascertained by observations of its regularity of speed. Whenever the velocity is great enough to enable the body to escape the attraction of the universe, the body is lost to it, and the other two bodies would be moving more slowly. If this should occur only once in a thousand cases—seeing that when it does occur the body escapes—given time enough, much of the energy of any individual system must thus be used up in allowing the escape of bodies.

103. If it could be shown that the impact of two similar universes would result in the formation of one which, in a similar stage, was of larger mass than one of the originals, then impact would be, on the whole, an aggregating agency, and the permanent equilibrium of the cosmos would be disturbed.

104. This is probably not the case, for during the impact of the universes themselves much matter would escape, and at every impact of individual bodies within the new universe light molecules would be set wandering that would ultimately leave the system. When the new universe has become more dense, during the approach of any three bodies one would occasionally be sent out of the system. There are other agencies that, together with these, render it possible for two

similar universes, by coalescing, to become one, which, when contracted to the size of either of its components, may retain no more matter than one of the original universes.

105. We have in these phenomena a complex series of agencies tending to overcome the dissipation of energy and the aggregation of matter. Impact developes heat, separates bodies, and diffuses gas. Radiation falls on the matter of space and heats it: this energy is taken up by the hydrogen to increase its velocity. As the hydrogen loses this new velocity it is carried to positions of higher potential. It will tend to linger in the empty parts of space, and it then becomes a trap for wandering bodies. These wandering bodies are separated from systems by the mutual interaction of three bodies.

106. Thus, in opposition to the theory of the dissipation of energy, there is seen to be the possibility of an immortal cosmos, in which we have neither evidence of a beginning nor promise of an end.

Art. LXIV.—*On an Oversight in Croll's Mode of lengthening the Age of the Sun's Heat.*

By Professor Bickerton.

[*Read before the Philosophical Institute of Canterbury, 3rd October, 1894.*]

Dr. Croll has suggested that the age of the sun's heat may be indefinitely lengthened if we assume the collision of two bodies with a high velocity. He says that if two bodies, each with a velocity of 478 miles a second, were to come into collision they would develope heat enough to last fifty million years. Doubtless his figures are correct; but the explanation is not sufficient. Such an impact would result in a nebula of the character I have described as producing a temporary star. When the two bodies collide the molecular heat-motion would be approximately equal to the velocity of the masses, and, disregarding "selective escape," each particle would move so fast that on its coming to the surface every one would leave on a journey never to return; and, in fact, a calculation shows that they would have a final velocity in space of over 300 miles a second. So that this method of accounting for the sun's heat contains a fallacy. In addition to this it has two essential elements of improbability—namely, the high initial velocity, and the improbability of complete impact.

Practically, then, Dr. Croll has not lengthened out the age of the sun's heat beyond that given by Sir William Thomson's calculation: his suggestion would make a temporary star, not a sun.

Still, there are many ways to account for an increase of the age of solar heat. As Proctor has pointed out, the sun may have a very dense interior: this would indefinitely lengthen out its age. And the rate of solar radiation might have been much less when the sun was larger and cooler than it is at present. It is impossible to say how far an absorbent atmosphere may retard the radiation.

I have pointed out this error because it was first stated in "Climate and Time," and after nearly a score of years it was again printed as the essential idea contained in Croll's book on stellar evolution.

Art. LXV.—*Notes on a Visit to Macquarie Island.*

By A. Hamilton.

[*Read before the Otago Institute, 13th November, 1894.*]

Plate L.

In the early part of 1894 I endeavoured to make arrangements to go down to Macquarie Island, for the purpose of studying the plants and the general natural history of that remote speck in the southern ocean. I also desired, if possible, to obtain a specimen of the skeleton of the great sea-elephant for the University Museum. There is a good stuffed skin in the collection, but there is no perfect skeleton of an adult male in the museums of the Australasian Colonies. Professor Scott, who visited Macquarie Island in 1880, brought back a good skeleton of a female sea-elephant, which is now in the Medical Museum of the University of Otago. I had several interviews with Mr. Hatch, of Invercargill, the owner of the ketch which is the sole means of communicating with the island, with a view to arranging for a passage; but his demands were quite beyond my means, and I had to abandon the project on the lines I had originally intended. I then suggested that Professor Parker, the Director of the University Museum, should get up an expedition, and if the necessary funds for my passage could be found I should be very glad to volunteer my services as an extra collector. With the help of some gentlemen who kindly assisted the professor by guaranteeing the necessary funds, arrangements were made with Mr.

Hatch for a passage to the island and back for Mr. Jennings (the Museum taxidermist) and myself, the University Council having kindly granted me leave of absence from my duties.

An excellent description of the general features of Macquarie Island has already been given in the Transactions by Professor J. H. Scott,* but there is still much interesting information to be gathered from an island so barren and inhospitable. Darwin said, in 1857, "It is my most deliberate conviction that nothing would aid more natural history than carefully collecting and investigating all the productions of the most isolated islands, especially of the Southern Hemisphere." This is certainly as true now as it was then; and, notwithstanding the discomforts and perils of the voyage, I should certainly like to have the opportunity of staying for twelve months on the island to complete a year's observations on the habits of the penguins and other birds, the few days which we spent on the island being quite inadequate for observations of much value.

Macquarie Island† is about 540 miles from the south-west cape of Stewart Island, and was discovered by the master of a sailing-vessel‡ early in the present century. It is said that no less than 80,000 fur-seals were obtained from the island by that party. Fur-seals are hardly ever seen there now.

The exact size of the island is unknown. The English chart made by Lieutenant Langdon in 1822 makes it thirty-eight miles long. The Russian navigator, Bellinghausen, in 1820, made it only nineteen miles long—probably as much too short as the other was too long. In 1840 Captain Wilkes, of the United States Exploring Expedition, landed a party on the island on the west side. There are bold outlying rocks at each end of the island. The bold rocky shores afford but little shelter and but indifferent anchorage, the water being deep close into the land: 10 to 90 fathoms are marked on the chart all along the east side at three miles from shore. At present the usual anchorages are on the east side—at the Nuggets and at Lusitania Bay. Both English and Russian accounts agree in making the island about five or six miles wide.

In 1890 an endeavour was made to get the island annexed or transferred to New Zealand, as it was found to belong to Tasmania, but without success.§ It was agreed, however,

---

* Trans., vol. xiv., p. 561; vol. xv., p. 484.

† Named after the Governor of New South Wales at that time.

‡ Captain Garbutt, in the brig "Concord," in April, 1811, and again in February, 1812. On both occasions his vessel was driven from her anchorage, and on the second occasion his boat was upset in the surf and all hands lost.

§ N.Z. Parl. Papers, App. to Journals of House of Representatives, Sess. II., 1891, A.–5, in cont. of A.–5, 1890.

that the taking of seals of any kind should be prohibited; and regulations to that effect, under section 12 of "The Fisheries Act, 1889" (53 Vict., No. 11), were issued in 1891 by the Tasmanian Government, and published in the *Hobart Gazette* (21st April, 1891). This being the law, it was necessary for us to apply for permission to kill some sea-elephants for scientific purposes. The requisite permit was kindly granted by the Colonial Secretary of Tasmania before we left New Zealand.

Like the other outlying islands of the South, there is already a mournful list of wrecks on this speck in the waste of waters, and some rude graves at the northern end of the island contain the remains of some who surely here rest in peace. The "Caroline," a ship supposed to have been named the "Eagle," and several others have gone to pieces on these shores. Though not wrecked on the island, the people of New Zealand will always associate the disappearance of the steamer "Kakanui"* with Macquarie Island, when nineteen men were lost on the return of the steamer to New Zealand. She no doubt foundered in one of the heavy gales which are so frequent in this part. In 1830 the "Lord Nelson" was lost at the north-west end. At a place now called Eagle Bay, about half-way down the west coast, the "Eagle" was lost, and her crew had to remain on the island about two years; some of them died before they were rescued. The "Caroline," a barque, was wrecked at the south end in 1838. The "Countess Cimento" was wrecked in 1849, about three miles from the north end, on the east coast; and in 1879 the schooner "Bencleugh" was wrecked near the same place.

The vessel in which we sailed is a smart little ketch of about 100 tons called the "Gratitude," and we embarked from Dunedin wharf with all our stores and collecting-material on the 22nd of February. This vessel usually makes three trips in the year—in December, February, and March. A good supply of stores was taken, as it was considered possible that Mr. Jennings might find it necessary to remain on the island till the vessel returned on the March trip. Besides ourselves, there were two boys from Dunedin as passengers, so the small cabin was very crowded.

Our passage along the coast was slow and uneventful. Between the Otago Heads and the Nuggets I saw some gannets and an occasional albatros (*D. exulans*). Being a very bad sailor, I was soon in "Sick Bay," and I got worse and worse, until at one time I thought I should never land again; and I was confined to my bed the whole of the voyage, both

* For particulars of the loss of the "Kakanui," 83 tons, 22 h.p., see Captain Fairchild's report on the result of the two searches, in the *Otago Daily Times*, 23rd February, 1891.

going and returning, with a bilious fever. The weather, from a landsman's point of view, was certainly boisterous and disagreeable. On the 25th February we saw the steep and majestic rocks known as the Solanders, and, having passed these, we stood to the westward, and felt that our voyage had now really begun. It is necessary to get a good deal to the westward in making a course for the island, as it is extremely difficult to approach from the eastward against the prevailing winds and currents. Between the 2nd and 12th of March we were tossed about, and sustained considerable damage to our sails and gear. Once we got down within a short distance of the position of the island, and a furious gale drove us back a long distance to the northward. The ship itself behaved splendidly, riding like a duck over the furious seas, and shipping very little water. Very few birds were seen after leaving the New Zealand coast. On the 10th a few petrels were seen about the ship; and in the evening land was sighted—the north-west corner of the island. All sail was crowded on to try and gain the shelter of the east side of the island from the stiff gale which was blowing. The gale increased, and we had the prospect of being again driven back, but by tacking off and on all night we managed to keep the land in sight, and in the morning bore down upon it, running in towards the Nuggets, the northern anchorage on the east side. Here we were met by a whaleboat from the island with some of the shore party in it. Delivering Mr. Hatch's letter of instructions, we arranged to be landed with all our stores at the southern station in Lusitania Bay. As we kept along the rocky coast-line we could see large colonies of penguins on the beaches between the headlands. Flocks of small grey petrels and mutton-birds flew round the ship, with an occasional black-backed gull and some giant petrels, or nellies. At Lusitania Bay we went in and dropped anchor within a few hundred yards of the shore in 15 fathoms of water. The wind increased in strength, and it was impossible to land, as, although the wind was off the land, there was too much surf. We had to amuse ourselves by watching the thousands of king penguins (*Aptenodytes*) sporting around us, sometimes chasing each other in strings like porpoises, at other times rushing by in a compact body, seemingly moving in concert, diving, and bobbing up and down, lying on their backs in a most comical way, and making every now and then a curious "quank," which at a certain distance and at certain times seems like a human cry. They manifested great curiosity, or else took the ship for a new kind of rock, as they were constantly pecking at the sides, and apparently trying to scramble on board. They were very quick in their movements, easily avoiding anything thrown at them by a sudden dive, reappearing the next

instant. We could not see that they caught anything in the way of food, but they seemed to come off in large parties from the shore and swim round the ship, playing and springing clean out of the water, and after a little time returning to the shore, landing on the crest of a wave, and scrambling up the stony beach in a most comical way. The wind swept down from the hills with such force that our anchor dragged, and in endeavouring to get it up the cable parted, and we lost the anchor and 45 fathoms of chain. We were not in a condition to go to sea again, so the vessel was run in quite close to the land, and another anchor dropped in about 8 or 10 fathoms. This fortunately held; and at 10 o'clock on the following morning (the 12th March), the tide being high, we were safely landed on the shingle-beach, after passing through the great beds of kelp which cover the rocks near the shore. Our party was left here while the ketch went north to the anchorage at the Nuggets to discharge her cargo of coal, casks, and stores, and take in her cargo of casks of oil for the Bluff.

The island has for some years been visited by parties from Port Chalmers and the Bluff, for the purpose of procuring sea-elephant oil and penguin-oil, both of which oils are much used in commerce, particularly in the manufacture of twine and rope. The slaughter of the sea-elephants has practically ceased, but the heaps of bones and the quantities of oil obtained indicate that a large number have been killed in the past. The chief industry now is the boiling-down of the royal penguin (*E. schlegeli*). For the purposes of the party, the fat birds are selected as they pass up and down from the sea to the "rookery," usually those of a year old. After being killed with a club, the penguins are bled and partly cleaned, and then thrown bodily into the steam digesters and steamed for some hours. The season for fat birds lasts only for about six weeks, and during that time the party are kept hard at work. This is at the end of January. The oil from the digesters passes into large vats, and the refuse is thrown out into heaps, and if there were any means of bringing it easily to civilized parts it would be of great value as manure. From the vats the oil is put into casks, and on the arrival of the vessel the casks have to be rafted out through the surf to the ship. This is a difficult and dangerous operation, and requires much experience and skill. The oil is refined at Invercargill. Mr. Hatch has been put to much trouble and expense in establishing the necessary buildings and machinery and the excellent accommodation, both at the Nuggets and at Lusitania, for the men who go down. These men usually form a party, and contract to furnish so many gallons of oil during their stay on the island. One very serious item of expense is found in the necessity for taking down all the wood and coal requisite for

the digesters and for domestic purposes. The factory at Lusitania at the king-penguin rookery is not now used; the great heap of refuse testifies to the great number of birds destroyed. No impression, however, seems to have been made on the numbers occupying the beach, as every available place seemed full of birds.

The area of the island is probably about the same as that of Otago Peninsula, and it has been already well described by Professor Scott before this Institute after his visit in 1880. The rough-sketch outline annexed (Plate L.) will give some idea of the relative positions of the places afterwards mentioned. The hut in which we lived at Lusitania stood on the crown of the shingle-beach. Immediately behind it was a small creek coming down from the hills at the back, over the sloping terrace thickly covered with a huge tussock grass. This grass (*Poa foliosa*) forms a huge stool, around which is usually a muddy pool more or less deep, into every one of which you plunge with unerring certainty when trying to cross the belt of tussock swamp, the only way to avoid this unpleasantness being to jump from the top of one tussock to another. Once beyond the belt of swamp you ascend the steep slopes of the hills, and here you struggle and wrestle with the huge leaves of the Macquarie Island cabbage (*Stilbocarpa polaris*), a plant resembling very fine rhubarb. The tussocks and the *Stilbocarpa* become smaller as you ascend, and at about 300ft. you gain a plateau so swept by the antarctic gales that vegetation is reduced to compact closely-growing mosses, small Uncinias, and the conspicuous cushion-like masses of *Azorella selago*. In the hollows of the uplands are countless little tarns or lakes, some of considerable extent. Round the tops of the hills the wind has cut out wonderful terraces from a few inches to a foot or two in height, with completely bare rock much disintegrated by the weather on the top. In some of the more sheltered places or gullies stunted plants of *Stilbocarpa* and *Pleurophyllum* cover the ground. The *Pleurophyllum* was, unfortunately, long past flower, and so I did not get any specimens of this beautiful aster-like flower, with its purple ray-florets and yellow centre. The majority of the plants on the island are littoral, and are to be found on the swampy ground near the beach. It is interesting to see how the introduced *Poa annua* has taken possession of the highly-manured soil on the crown of the beach, and radiates from the settlements, together with some other introduced weeds. From the ship it appeared as if there were some good-sized bushes or shrubs growing on the lower levels, but on landing these were found to be only huge detached rocks overgrown with mosses and large tussocks of *Poa foliosa*. On the whole of the island there is not

a shrub or plant large enough to make a penholder. Indeed, the only plant of a ligneous genus is the small creeping *Coprosma repens*.

From the list given by Professor Scott, and the revision of the Macquarie Island plants published by Mr. T. Kirk in the Proceedings of the Australasian Association for the Advancement of Science, it was evident that there was very little chance of finding any useful shrubs; so before leaving Dunedin I determined to try and establish some on the island that might some day be of use, at any rate, for firewood. Mr. Matthews, of Mornington, kindly gave me a large bag of seeds of several New Zealand *Pittosporums*, and of a variety of deciduous trees. Messrs. Howden and Moncrief also gave me some seeds of several varieties of pines. I also took a quantity of cabbage-seed. I took the opportunity of sowing these seeds in various places around Lusitania Bay, and I trust that some of them may become established. Somehow the very seed that we ought to have taken—manuka (*Leptospermum*)—nobody thought of. This would have been probably the best calculated to succeed in that climate, and would have been of service for fuel. The time of year was an unfavourable one for the experiment, as the winter was just coming on, and the germinating plants would experience the cold at the most critical time. The large *Poa* tussocks are the great feature of the low levels, and on the hill-tops the special feature is the *Azorella*, masses of bright-green closely-growing convex masses of stems and leaves. These masses are so solid and elastic as to bear the weight of a man without material injury. Embedded in the substance of this cushion grow two small but interesting plants—*Coprosma repens*, with its striking dimorphous flowers and scarlet berries; and a very minute form of a fern, *Polypodium australe*, the frond of which is about ½in. long. This truly alpine form I have collected on the top of the Kaweka Mountains, in Hawke's Bay. Two other ferns are found on the island: the one is *Lomaria alpina*, the other *Aspidium aculeatum*, var. *vestitum*. The plants which I collected on the island have been submitted to my friend Mr. Kirk and to Mr. Petrie, and I have to thank them very heartily for the trouble they have taken in identifying the specimens. I had hoped to find something very new and striking in an island which the soundings show to be separated by a deep submarine valley of 1,000 fathoms from New Zealand, but the results seem to support the conclusion arrived at in the report on the "Challenger" voyage: that the composition of the vegetation of the remotely-separated exceedingly small islands in the southern seas, on the extreme limit of phanerogamic life, is practically the same all round the globe, and is, in all probability, the remains of a more ex-

tended and possibly continuous belt, because the present conditions cannot be accounted for by the ordinary means of dispersal.*

List of Plants collected.

Ranunculus crassipes, Hook. f. Variable size; growing in the swamps and on the sides of the "stools" of the *Poa*. In exposed situations the ripe carpels become scarlet and very conspicuous. The leaves are also smaller and stouter. [Note by Mr. Kirk: "Some of the carpels have a faint marginal ridge in the young state, which becomes absorbed before they reach maturity. This is probably the *R. aucklandicus* of my list,† the *R. acaulis* of Professor Scott's paper,‡ which was represented by a mere scrap. This species should be placed next to *R. macropus*, Hook. f."]

Cardamine hirsuta, L., var. *corymbosa*. This plant formed a green margin to the vegetation on the top of the beach wherever a creek or swamp ran out to the sea.

Colobanthus muscoides, Hook. f. Tufts on the rocks on the beach and cliffs; in some cases must be frequently drenched with salt water. [Note by Mr. Kirk: "Doubtless the *Azorella lycopodioides* of Professor Scott's list. The larger tufts are very like the masses of *Azorella selago*."]

Colobanthus billardieri, Fenzl. Not so plentiful as the preceding.

Stellaria decipiens, Hook. f. [Note by Mr. Kirk: "Through a slip of the pen, '*S. elatinoides*' was inserted in my list (of 1891) instead of '*S. decipiens*.'"]

Stellaria media, L. One of the plants which have succeeded in naturalizing themselves near the factories, having probably been introduced in the straw packing of the machinery, &c., together with

Cerastium triviale, Link. [Note by Mr. Kirk: "An unusually luxuriant state, with almost fleshy leaves."]

Montia fontana, L. Grows in the same situation as *Cardamine* and *Callitriche*. It is recorded from Kerguelen's Land and from South Georgia, lat. 54° S., and long. 37° W.§ All these three might easily be dispersed by the mud of their habitat containing the seeds adhering to the feet of ducks, &c.

---

* Botany, vol. i.; Introduction, p. 57. See also Science Progress, July, 1894, p. 395: W. Botting Hemsley

† On the Flora of Macquarie Island: Report of the third meeting of the Australasian Association for the Advancement of Science, pp. 226, 227; 1891.

‡ Professor J. H. Scott: "On the Fauna and Flora of Macquarie Island"; Trans. and Proc. N.Z. Inst., xv., pp. 484–938.

§ Dr. Will: "Die Phanerogamenflora von Süd-Georgien": "Botanische Jahrbucher," vii., pp. 281–285.

Acæna sanguisorbæ, Vahl. This is *A. buchanani* of Professor Scott's list. *Acæna* occurs on Kerguelen* and on South Georgia. An infusion of the leaves of this plant is said to be a febrifuge and an efficient anti-scorbutic by whalers, and is sometimes known as "Kerguelen tea." (Kidder.)

A. adscendens, Vahl. [Note by Mr. Kirk: "This species was collected on Macquarie Island by Fraser." Handbook N.Z. Flora, p. 56.]

Callitriche antarctica, Engl. This species was without flower or fruit at the time of my visit, so the identification can hardly be positive, but the same species occurs at Kerguelen and on South Georgia.

Epilobium nummularifolium, A. Cunn. Growing in the swamps.

Epilobium linnæoides, Hook. f. A prostrate form. This species is also recorded from Antipodes Island and the other islands up to New Zealand.

Azorella selago, Hook. f. No flowers or fruit could be found on any of the specimens seen. [Note by Mr. Kirk: "Kidder states that he could not find hair or bristles on the upper surface of the leaf in the Kerguelen plant. They are present in these specimens, which have neither flowers nor fruit."]

Stilbocarpa polaris, Hook. f. A noble plant, which grows in perfection on the steep slopes of the cliffs. Its local name is Macquarie Island cabbage.

Coprosma repens, Hook. Growing in the masses of *Azorella* and in the tufts of moss on the higher grounds. [Note by Mr. Kirk: "Stamens four; stigmas four in many flowers. Interesting as attaining the highest southern limit of ligneous vegetation."]

Cotula plumosa, Hook. f. This handsome plant grows well along the littoral belt, but not so luxuriantly as in the Auckland Islands. Recorded from the Crozets and Kerguelen's Land by Dr. Kidder and by the English Transit of Venus Expedition,† who also noted that the whalers consider an infusion of this plant to be a prompt and effectual emetic. (Hooker, *fide* Rev. A. Eaton.)

Pleurophyllum hookerianum, J. Buch. This handsome plant was long past flowering when we landed, and the tips of the silvery leaves were frost-bitten. The last flowering did not seem to have been very general, as a very small

---

* Kidder, J. H.: "Contributions to the Natural History of Kerguelen Island": Transit of Venus Expedition, 1874–75, pt. ii., p. 23.

† J. D. Hooker: "Flowering Plants, &c., Kerguelen Island," p. 9, Trans. Royal Soc., No. 168 (extra volume).

percentage bore the dry flower-spikes. On one plant there were nine of these, bearing the remains of 164 flowers. The seedlings, even while the leaves are less than 3in. long, have strong stout rootlets, which go down through the mass of vegetable matter in which they grow. There is absolutely no sand or loam for them to grow in—nothing but decayed vegetable matter. In a specimen before me, in which the leaves are about 20mm. long, the rootlet is 160mm. in length. Mr. Kirk notes that "the leaves of the young plants approach those of *P. criniferum* more nearly than specimens from Auckland and Campbell Islands, but the identification is certain. This is doubtless the *P. criniferum* of Professor Scott's list." The edges of the leaves carry stiff bristles. The silvery patches of this handsome plant show out plainly among the mosses and grasses in the drier parts of the swamps, and in sheltered places on the uplands.

Uncinia nervosa, Boott. [Note by Mr. Kirk: "This plant is intermediate between *U. compacta*, R. Br., and *U. tenella*, R. Br.: the leaves closely approach those of the former, while the fruits resemble the latter, but are of a darker colour, and more glossy. The spike is scarcely longer than that of *U. tenella*. It is *U. cheesemanii*, Bœckeler."]

Luzula crinita, Hook. f. This appeared to be the only *Luzula* on the island. I failed to get *L. campestris* of Professor Scott's list.

Deschampsia hookeri, T. Kirk,* var. *inermis* and var. *effusa*. [Mr. Kirk says, "Both are interesting varieties of one of the most variable grasses in the colony."] Mr. Petrie considers the first to be *D. tenella*, Petrie.

Deschampsia penicillata, n. sp. (MS.), T. Kirk.† A puzzling species, which is provisionally named pending the examination of the other species new to New Zealand.

Poa foliosa, Hook f., *a*. This noble grass forms huge tussocks, especially in the damper portions and where the drainage and the liquid manure from the penguin rookeries assists its growth. In such places one can walk between the columns with the plant waving far overhead.

Poa hamiltonii, T. Kirk.‡ [Mr. Kirk says, "Allied to *P. anceps*, Forst., and *P. foliosa*, Hook. f. One of the most distinct species in the flora."]

Poa annua, L. Naturalized, and doing very well.

Agrostis antarctica, Hook. f. = *A. multicaulis*, Hook. f. [Mr.

---

* "Journal of Botany," 1891.

† See "On New Grasses from Macquarie Island," by T. Kirk, above, p. 354.

‡ Above, p. 353.

Kirk says, "The palea is poorly developed, or absent in many flowers. = *A. multicaulis*, Hook. f., and I think this name should have precedence."]

Festuca contracta, T. Kirk, n.s. [Mr. Kirk says, "Certainly not *F. duriuscula*, L.; but the specimens are not very good, being mostly too far advanced, and many of the glumes are infested with a small *Sphæria*."]

Aspidium aculeatum, Swn., var. *vestitum*. A very coarse form, with large and beautiful scales. The patches of this fern, being of a very dark colour, are visible against the lighter green of the *Stilbocarpa* and the yellow of the dead grass for some distance.

Polypodium australe, Mitt. Plentiful in clumps of *Azorella* on the highest parts of the island.

Lomaria alpina, Sprengl. Not seen near Lusitania, but obtained on the west coast.

Lycopodium billardieri, Sprengl., var. *varium*. The habit is like that of *L. selago*, but denser; the leaves are much broader. Seedling plants growing amongst the stems have distant oblong leaves. Found on the hills immediately behind Lusitania Bay.

In addition to the above plants, I also collected *Tillæa moschata*, DC.,* and two species of Cyperaceæ, but the whole of the specimens of these were lost in the accident which occurred on the homeward voyage. The mosses and lichens collected were so injured by the wet, and by the delay of some months which occurred before they were brought up from the island, that I fear it will probably be impossible to give a list of any value.

At the time of our visit the king penguins (*Aptenodytes*) had nearly finished their breeding-season, and the royals and victorias (*E. chrysolophus* and *pachyrhynchus*) were moulting. The chief king-penguin rookery seen by us was the one at Lusitania Bay. Here a small stream comes sparkling down under the overarching leaves of the *Stilbocarpa*, and spreads itself out over the fan-like talus of rock-fragments brought down by its waters and the coarse blue shingle which composes the beaches, and eventually trickles through the looser portion to the sea. Moseley,† in his description of the penguin rookeries at Tristan d'Acunha, gives a vivid description of the discomforts of crossing through one of these large collections of birds; so we had taken the precaution of having some strong canvas leggings made, and were thus well "armed," or defended,

* See above, Art. xliii., "Description of New Grasses from Macquarie Island," by T. Kirk.

† Moseley, H. N.: "Notes by a Naturalist on the 'Challenger,'" 1879, p. 113.

from the vicious pecks and the vigorous blows from the wings of the birds. The interest and the novelty of the sight of 30 or 40 acres of penguins made up for the deafening noise and the fearful smell, and we found that if we stood still the birds did not take the trouble to move or bite. Some of the birds were fighting with their neighbours, standing still, either in a puddle or on a wet slimy stone, but keeping their wings and bill in constant action, their apparent object being to make everybody keep his regulation distance from the others. No sign of a nest is to be seen. Subangular fragments of rock covered with slimy black mud cover the ground, and the beautiful white breasts of the birds were simply filthy with the splashings. Some few birds just at the edge of the crowd (late arrivals, I suppose) had eggs not yet hatched, one egg to each bird, and this egg was carefully carried on the two big black feet, with a fold of the skin of the abdomen tucked over it. They even found it possible to move about like this, with the egg in this curious position, much resembling a boy in a sack-race. There were others whose anxieties were over, and who had the care of a fat little chicken, as black as a coal and very helpless. They all endeavoured to get as far under their parent as possible; but these seemed to be very little protection for them. During incubation I am told that the male relieves the female about every two days, but I cannot affirm this of my own knowledge. There is no perceptible difference between the males and the females. The distance allowed around each bird seemed to be about 1ft. 4in., and any encroachment on this area caused an immediate squabble, which only ceased when the intruder had been driven out and order restored. This large rookery reaches from the crown of the beach to the foot of the hill-slope or cliff, and appeared to be devoted entirely to the breeding birds, a constant stream of birds passing up and down from their stations in the rookery to the sea and returning again. Some of the young birds were of large size, and the down which covers their body of a dark-brown or black colour. In a few cases I saw the young birds fed, their parent giving up some part of its own dinner. I could not ascertain if a bird always returned to exactly the same spot; from the amount of struggling and pushing going on I should imagine that they did. The slopes of the beach in front of the breeding-ground were apparently devoted to the bachelors, and the birds who occupied various nooks and corners and small grassy plots between the tussocks seemed to attach themselves to these particular places. I marked one fine bird that belonged to a party of about twenty who occupied the open grassy place just under the window of the small room in which I slept, and, with the exception of an occasional short

absence for a swim, he and his friends were generally within a very short distance of the house, and always spent the night there. I took one of the large brown young birds, nearly as large as an adult, from the middle of the breeding-ground, and carried it down to the beach, and let it loose amongst the bachelors and the "unemployed." Directly I put it on the ground it set up its cry of distress—a very shrill whistle, quite unlike the hoarse croak of the adult. It was set upon at once by all the birds in the neighbourhood, and thrashed and driven up the beach towards its proper quarters. If it went in any way out of the direct line half a dozen birds would make a furious rush to turn it into the right path, and they only left it when it regained the rookery and vanished in the crowd.

Nearly the whole of the Lusitania beach, over half a mile in length, is occupied by king penguins; but a small colony of royal penguins were camped at one part, moulting, probably crowded out of some other beach. These birds have thick, powerful beaks, and they varied their existence by most desperate duels for the most trivial causes, striking each other about the head till the blood flowed freely. These birds are much smaller than the kings, but have an attractive crest of yellow feathers when in good plumage.

Sailing about overhead were numbers of the dark-coloured hawk-like skua gull—*Lestris antarctica* (*Stercorarius antarcticus*)—the terror of all other birds. The working party find them so destructive to the young penguins that, by means of poison, a very large number have been killed to protect the oil interest. They are still extremely numerous. I did not, however, find them so bold as some have reported them. Not being their breeding-season may have made the difference.

A little to the southward of the Lusitania beach is a breeding-place of the victoria penguin (*E. filholi*), and the air was filled with the flying feathers and down from the moulting birds. These little birds are very active, and climb up and down the face of the cliffs in a most agile manner, and are much more entitled to the name "rock-hopper" than the other species (*Pygoscelis tæniata*), which are much less plentiful and more lumbering in their gait.

There are four kinds of penguins on the island. The king penguins (*Aptenodytes*) do not make any attempt at a nest; the royal penguins (*Eudyptes schlegeli*) carry up stones or bones from the beach to a convenient place amongst the grass for their nests; the victorias (*Eudyptes filholi*) pluck grass and form a rough nest; the rock-hoppers (*Pygoscelis*) do the same, generally on the slope of a cliff. The kings lay their eggs from December to February or March; the royals lay in September, and also the rock-hoppers; the victorias in

September. At certain times in the year the birds become extremely fat. In February a fat royal penguin will weigh 14lb.; a king penguin will weigh at least 30lb. It seems to be pretty well established that all the four kinds of penguins migrate and pass a portion of the year somewhere to the southward, but there are no regular observations on the point. I was not able to ascertain what kind of food was available for the birds at the time I was there: all the birds examined had nothing but a brown slime in them as food.

Shags were often seen flying by or sitting quietly on the rocks. On our first walk along the coast to the south we came on a breeding-place where there were numbers of all ages, and by carefully crawling up the rocks we managed to secure three specimens by hand. On sending down a man the next day to procure some more he found them much more wary, and had to shoot those he required. The species is one common to the islands to the south of New Zealand (*Phalacrocorax carunculatus*). Some distance to the north of the Lusitania hut there is a beautifully arranged breeding-place of this shag, with about thirty nests arranged in terraces on a huge rock, each nest being on a little pedestal, the accumulation of years.

Ossifraga gigantea.—The huge and ungainly "nelly," handsome and even noble when wheeling round and round in the air, is on the land but a lumbering robber, and usually to be found skulking around the breeding-places, trying to pick up a young penguin or wood-hen. The breeding-places are upon the bleak moorlands on the top of the island. In one that I saw there were about fifteen or twenty young birds almost ready to fly, and out of the hundred or more birds in the breeding-place there must have been at least a dozen pure or partial albinoes. The whole surface of the island is covered with the bones of small Prions, swallowed and then ejected by these giant petrels.

Ocydromus.—Some years ago Mr. Elder turned out some Maori-hens from New Zealand, and these have increased and multiplied in a most extraordinary way. On any part of the coast (with the exception of the extreme north) they may be seen feeding on the small crustacea and mollusca amongst the kelp. They might well be called kelp-hens, as their colouring is so assimilated to the shades of brown taken by the wet and dry kelp that it is only when they are moving or are on the shingle that they can be distinguished. It was a very easy matter to knock over with stones enough of these birds to make a most excellent stew, and no fear need ever be entertained of any castaways or inhabitants starving on Macquarie Island, as these birds alone would be quite sufficient to provide plenty of nourishment. They are just as inquisitive

as on the mainland, and several were killed under our beds, having come into the house when the door was left open. Whilst mentioning food-supplies I may say that rabbits are fairly numerous in the south-east; they have disappeared from the north owing to the wild cats, which are very numerous and of great size.

Another important food-supply is derived from the mutton-birds, probably two species. These were seen at sea, but they had not commenced to lay at the time we left, although daily expected. They must be very numerous, to judge by the burrows on the hills. A little dove-petrel (*Prion banksii*) flies to sea at night-time, and is much persecuted by the *Ossifraga* and the *Lestris*.

Larus dominicanus.—The black-backed gull was fairly plentiful at the time of our visit, and also the small terns, *Sterna frontalis* and *Sterna antarctica*. The latter was only seen at the northern end of the island.

Professor Scott, in 1880, included in his list a green parrakeet, which at that time was plentiful all over the island, and nested in the vegetation covering the large rocks on the beach. I had also heard from a man who had been working on the island some years later that they were plentiful along the seashore near the isthmus at the north end. We took down some cages to bring back some of these, but our utmost endeavours failed to procure or even see a single specimen. The party at present on the island have not seen any during the two years they have been there. One of them told me that he had seen a large flock of them fly away northwards when he was on the island about four years ago. It seems pretty certain that these birds have either migrated or have been exterminated by the wild cats which have spread over the island within the last few years. The migration theory is scarcely likely, as all accounts represent the parrakeets as having lost by disuse the power of sustained flight. On the other hand, the birds seem to have disappeared from all parts of the island, whereas the cats do not seem to have reached the south at present. The parrakeets are said to have frequented the heaps of seaweed on the seashore in search of the crustaceans and other small forms of animal life. The loss of this bird is much to be regretted, as we can hardly doubt that it would prove to be a local race corresponding to the forms found on the Antipodes and the other groups of southern islands. There is no specimen of this bird in the Otago Museum.

Of *Rallus macquariensis** Professor Scott says, "Not

* Buller's "Birds of New Zealand," 2nd ed., p. 95; and Hutton, *Ibis*, 1879, p. 454. There is a specimen from Macquarie Island in the Otago University Museum, presented by Elder and Co.

at all uncommon. There seemed to be two varieties: one, slightly the larger, was reddish in colour; the other was black." This bird is considered by Sir Walter Buller to be a local variety of *R. philippensis*, and I wished very much to procure specimens of the two kinds mentioned in the above quotation. Not a sign of either was seen by us, and I could not hear from any of the party on the island that any had been seen.

Professor Scott mentions that teal were occasionally seen on the lakes. I could not hear that any had been killed, but I saw the common grey duck (*A. superciliosa*) on the coast, and on some small inland lakes. These birds have a very wide range, but I do not think they have been reported from Macquarie Island before.

Most of my notes were made at Lusitania; but I was on the North Head for a few hours on the day we left, and there I noticed, on a bare wind-swept surface of clay, great quantities of rounded stones exactly like the moa gizzard-stones found in New Zealand, but smaller. These have probably accumulated in the course of time from the birds destroyed by the skuas and nellies, the remains of which are found all over the surface of the island, ejected by these offal-feeders. At the narrow neck of land connecting the North Head with the mainland I saw a large heap of the bones of the sea-elephants, which had been gathered together with a view of taking them to New Zealand for bone-crushing. Near the heap was a stretch of shifting sand, which revealed evidence that this was the site of the large rookery of king penguins seen here by Bennett in 1815, since entirely destroyed. Amongst the bones I found two perfect skulls of a very large species of albatros. These I specially valued, as we were unable to verify the statement that a species of albatros breeds on Macquarie Island, or to say what the species was. The skulls, together with a valuable collection of other specimens, were swept overboard on our homeward passage.

Of the mutton-birds frequenting the islands, one species, which we only saw on the wing whilst off the island, seemed to be new.

The list of birds will stand somewhat as follows:—

Platycercus. Probably extinct.
Larus dominicanus.
Stercorarius antarcticus (skua gull).
Sterna antarctica.
Sterna frontalis.
Rallus macquariensis = *R. philippensis*. Not seen or heard of.
Ocydromus. Introduced.
Phalacrocorax carunculatus.
Diomedea . . . (?)

Prion turtur.
Prion banksii.
Prion vittatus.
Œstrelata . . .
Ossifraga gigantea.
Puffinus . . . (?)
Puffinus . . . (?)
Garrodia nereis.
Fregetta melanogaster. (?)
Anas superciliosa.
Eudyptes chrysocomus (victoria penguin).
Eudyptes schlegeli (royal penguin).
Pygoscelis tæniatus (rock-hopper).
Aptenodytes longirostris (king penguin).

As I mentioned at the commencement of my paper, the object of our visit was to obtain good specimens of the skeleton of the adult male sea-elephant—*Morunga elephantina* (*Macrorhinus leoninus*). The season at which we went was not a favourable one for the purpose, as the only specimens we saw were on the wild west coast of the island. Taking advantage of a fine but cold day (the average temperature during our stay on the island, taken at 9 a.m., was 50°) we crossed in a south-west direction to the west coast, and, after struggling over the bare and bleak hill-tops against the icy blasts from the antarctic, we descended to a sheltered bay, and here we saw several of the huge monsters among the large tussocks some little distance from the stony beach. Each animal had formed a kind of wallow in the wet swampy ground, and seemed to be passing the time in sleep until the old coat had fallen off and a new fur had grown. All seemed fat and quite happy. One old gentleman remained whilst I took several photographs of him at a distance of a few feet, and, as I was anxious to get a photograph of the distended nose, which is so remarkable, we pelted him with stones until he raised up his head, inflated his nostrils, and roared. Unfortunately the photographs were not very successful, but, as the aspect of this curious inflation is of some interest, I have given an outline drawn from the life and from a photograph taken at the same time (Plate L.). After some further teasing the old fellow went down to the sea with an awkward-looking but rapid motion. Two other specimens at the other end of the beach were sketched, and then driven out to sea. One of them, strange to say, reared up and roared, taking exactly the form given in the old voyagers' plate, which apparently looks so absurd and impossible.* Once in the water they went out to

* *See* Anson's Voyages, 1742. The plate No. xxxii. in the Paris edition, 1807, of Peron's Voyages, gives a very fair representation of the head and trunk.

sea through the kelp like torpedo-boats. Many of those we saw had scars and recently-healed wounds, and when Mr. Jennings and the rest of the party were killing and preparing the skeleton further up the west coast some males were seen in the water fighting desperately, rising straight up in the water, throwing their huge bulk against each other, and tearing great strips of skin with their tusks. Mr. Jennings selected four of the finest specimens, apparently adults, and, after shooting them with a carbine, found that the skins were in too poor a condition to be of any use for specimen purposes. He therefore, with very great labour, and under very great hardships from the want of sufficient food and proper shelter at night, stripped the flesh of all four elephants from the bones, and carefully prepared the bones for transportation across the island to a place called South-east Harbour. With the assistance of one of the men on the island he succeeded in carrying across the four miles of most difficult country the heads of the four specimens and the complete skeleton of the smallest of the four, together with some of the most important of the small bones of the remainder. It was found impossible to bring over the remainder at that time. Mr. Jennings carefully examined the intestines and stomach, but could find nothing but a brown slime—possibly the remains of kelp. The ground in the neighbourhood of the bodies was saturated with blood, and the skuas and nellies gorged themselves to repletion. Although the specimens selected for slaughter appeared fully adult, it was found, when the skulls were finally cleaned, that very few sutures had closed, and that they must remain open for a long time after the animals are apparently full-grown, all of the four killed measuring over 20ft. in length. I also noticed that in the huge heap of bones at the north end all the bones appeared to be of immature individuals. It is to be regretted that, owing to a series of misfortunes, only one of the skeletons should up to the present have reached Dunedin —and that one slightly imperfect—as the work of preparing the skeletons was performed under the most trying circumstances, and involved a great amount of work.

I was unable to accompany the party who went for the sea-elephants, as I had to remain at Lusitania. Along the coast-line I collected several skeletons, more or less perfect, of very young sea-elephants, about 8ft. long. I had one adventure with a female sea-elephant, the only one seen during our visit. I came on it one morning on the upper part of the beach, but was unable to kill it, as it escaped to the sea badly wounded. It was about 9ft. long, and had a beautiful light-brown coat, much more attractive than the mangy-looking coats of the males. Professor Scott records that they calve after October. Judging by the remains of skeletons on the various

beaches, the only other seal that is at all plentiful here is the sea-leopard seal (*Stenorhynchus leptonyx*). I believe that the time at which we were on the island is one at which both sea-leopards and sea-elephants are generally absent. I saw several of the fore-flappers of this seal pickled for eating. They are said to be very good, but we were not there long enough to come down as far as that. The sea-elephants are said to be much scarcer than formerly, and they do not range much to the northward at the present time, although there is a skull of a very aged individual in the Otago Museum, found at Oamaru, and one in the Colonial Museum at Wellington, found near Castle Point.

Fishes.—In the tidal pools at low water some small gobies were found, which have not yet been examined critically, but I think one of the two species is *Harpagifer bispinis*, also found at Kerguelen. A good-sized fish was obtained by fishing with a hook from one of the rocks, and specimens were preserved, but have not come to hand; and two small specimens were picked up on the beach of a small sprat-like fish. The terns and gulls were seen one day pursuing and diving into a shoal of fish passing along the coast with the strong current to the north-east.

Mollusca.—The rocks exposed by the tides at Lusitania Bay are not very extensive, and are much swept by the shingle, so that the area is not a good collecting-ground for invertebrates. Between South-east Harbour and the Nuggets I saw a large area of exposed flat reef which I had not time to explore. The most attractive shell is a bright scarlet bivalve which attaches itself to the bright-green *Ulva* in the rock-pools and to the kelp in the deeper water. It is very plentiful, and I think it is *Lasea rubra*, or a *Kellia*. There has not yet been time to get the few species examined, but they will be worked up later on. A careful search for land or fresh-water mollusca resulted in the finding of only one species, which Mr. Suter refers to *Laoma campbellica*, Filhol (No. 139, 1880), a species already known from Campbell Island. It is a minute species, and occurs plentifully in the decayed vegetation everywhere. I was much disappointed in not finding any fresh-water mollusca.

Three species of spiders were found under the leaves of the *Stilbocarpa*, and a few small flies were caught in the same situation, one being apterous.

I also collected some earthworms, which have, I believe, been sent Home for examination. The ponds and tidal pools were infested with small white worms, and a small black marine planarian was common. Some starfish, echinoderms and holothurians, were also collected, but have not yet been identified.

Mr. G. M. Thomson has kindly examined the crustaceans collected, and has written a note for this volume of the Transactions.*

On the 22nd of March I walked along the coast-line from Lusitania Bay to the Nuggets, and saw a number of most interesting rookeries of the royal and victoria penguins, and some very romantic rock-scenery. The next morning, as I was commencing to examine the north end of the island, the wind changed and began to blow furiously from the north-east, and snow fell, and it was with some difficulty and danger that we were taken off from the beach to the ship. I was knocked down by the surf whilst getting into the boat, and got very wet. The weather, instead of moderating, became so bad that, without being able to communicate with the island again or to take our goods or specimens on board, the captain had to run for the Bluff without waiting to complete his cargo.

On the morning of the 26th (Easter Monday), while running before wind and sea, a very heavy sea broke on board and swept the decks, washing overboard a large surf-boat and the ship's quarter-boat with davits, the cook's galley, with the cook and a young Maori boy in it, and one of the watch on deck. The heavy sea running rendered it impossible to do anything to try to save the men: nothing was ever seen of either men or wreckage. The log recorded a calm at 4 a.m., and at the time the wave came, about 8.30, the barometer was down to 28·15°. There was comparatively little wind till the barometer began to rise, which it did at the rate of about 0·1 an hour. The wind was from E. to S.W. and S. After this we had a fairly good passage, and landed at the Bluff on the 31st of March.

We had to leave the island with just the clothes we wore, and leave everything on the island that we had collected. Some of our things were brought up on the next trip of the boat, but, as might be expected, a number of valuable specimens were ruined, and others never reached us. My photographs and apparatus were brought safely, but, as I said above, the photographs were not satisfactory as works of art. They, however, are of interest as showing several points with greater accuracy than any drawing could do.

I have to thank Professor Parker, the Curator of the Otago University Museum, for the permission to use the specimens collected for the purposes of my paper, and Mr. Jennings, the taxidermist to the Museum, whose kindness to me during my illness on the voyage both down to the island and back to the Bluff I can never forget.

---

* See above, Art. XXII., p. 210.

NOTE.—In the list of the manuscripts presented by Sir George Grey to the Capetown library, South Africa, there is a diary kept by a Mr. John Cook, who resided on the island for six months in 1850.

I have also a memorandum as follows: "'A Sojourn on the Macquarrie Islands, and Sufferings of the Hunters': Capt. Sinclair; October, 1877–8." This, I suppose, will be an account of the wreck of the schooner "Bencleugh," but I cannot find the description.

ART. LXVI.—*Myths of Observation.*

By EDWARD TREGEAR.

[*Read before the Wellington Philosophical Society, 19th September, 1894.*]

THOSE who have written on the transmission of the Hebrew Scriptures tell us concerning the sacred books that the utmost jealousy was observed in regard to a single "jot or tittle" being omitted or added; that any such departure from faithfulness in transcription was sufficient to bring about the destruction of the imperfect copy. There are some who deny the possibility of any great accuracy in regard to tradition, they apparently having imbibed the notion that unwritten story, passed from one to another, must necessarily have lost or gained much in personal transfer. This may to some extent be an idea based on insufficient evidence, and arising from too close arguing on lines of analogy drawn from individual experience. It is made certain by the legends collected at the present day all over the world that tradition may be orally transmitted, if not with the word-accuracy which renders the Jewish record so valuable, still with a verisimilitude and faithfulness of description which would make many of our literary "eye-witness" stories seem very misleading and doubtful in comparison. For hundreds of years, from priest to disciple, from Brahmin to Brahmin's son, has the Rig-Veda been handed down in India side by side with the written text, but with the oral version deemed more sacred and kept more jealously than the script itself. So has the Kalevala been transmitted for centuries, from old days before the Finns turned from heathendom, and the great epic has only been collected and pieced together during this generation.

The Polynesians, who have been separated and scattered so long that their language (which is at base but one) has

differentiated in the island-groups until the New-Zealander cannot understand the Tongan, nor the Samoan the Tahitian, —whose customs, religions, tattooing, all have become distinct, —still hand down the same legends almost word for word, unchanged by the passing of many centuries. These stories have in most cases been preserved by religious influences, the traditions relating mainly to gods and heroes round whom was wrapped much of awe and mystery. In New Zealand the priestly incantations and legends were perpetuated with a very lively sense of the deadly consequences of error and the fear of offending celestial persons whose resentment would be aroused by a careless slip or want of reverential attention. Years were spent in arduous training and in discipleship to learned teachers, and no innovation was possible in the authorized version recited in the presence of fiercely-critical elders. This short preamble may not be considered unnecessary as explaining why these legends are not to be looked on in the same light as mere tales of fiction invented at the present day to pass an idle hour. They are in many cases the heir-looms from an incalculably remote antiquity—a time, in my opinion, far antecedent to that covered by any historical period or literary record. Of course they are not all of equal value: some are corrupt, and others have been related by partially-uninstructed persons; but by the student of mythology and folk-lore points are to be perceived that tell of age and authenticity by subtle processes that the surface observer is not able to appreciate, just as to the eye of the naturalist important differences of allied species are apparent that the untrained by-stander would not only pass over, but might, with self-sufficiency, refuse to believe exist. They *do* exist, however, and in a similar manner intrinsic evidence of high antiquity is often presented to the trained student of mythology.

Concerning the deluge, I shall not in this paper dwell upon the many legends. They are to be found all over the world, and perhaps in no finer or more original manner than in the Polynesian hymns and traditions. To compare the allusions recorded by different ancient peoples would make a paper of exceeding length, and I trust that at some future time I shall be enabled to compile the different accounts, and show that they are of great (sometimes local) interest, even in regard to scientific points which are mere details of the stories. For the present I shall touch on a class of the traditions which seem to prove that, in some manner to us incomprehensible, the deluge of water was preceded or accompanied by another great catastrophe—namely, that of a terrible conflagration. The Hebrew account gives no hint of this, nor does the Chaldean, except perhaps by obscure references. It is only through the legendary statement of primitive peoples

widely separated that we acquire the idea that the memories of many scattered tribes have preserved the recollection of some terrible event in the far-off past, having a destructive fire for its source of terror, as it ravaged the inhabited lands. Hesiod tells us the story of the strife between Jove and Typhœus, and describes the coming of the fiery spirit :—

"Beneath his [Jove's] immortal feet vast Olympus trembled as the king arose and earth groaned beneath. And the heat from both caught the dark-coloured sea, both of the thunder and the lightning and fire from the monster. And all earth, heavens, and sea were boiling, and huge billows roared round the shores. . . . So, I wot, was earth melted in the glare of burning fire."*

This tale, of course, might be thought to be a mere poetic fancy as to the conflict of the good and evil powers, but the references come with singular coincidence from far-distant places.

The legend of the British Druids records the double deluge of fire and water : "The profligacy of mankind had provoked the great Supreme to send a pestilential wind upon the earth. . . . At this time the patriarch, distinguished for his integrity, was shut up, together with his select company, in the enclosure with the strong door. Here the just ones were safe from injury. Presently a tempest of fire arose. It split the earth asunder to the great deep. The Lake Llion burst its bounds, and the waves of the sea lifted up themselves on high around the borders of Britain ; the rain poured down from heaven, and the waters covered the earth."†

Here we have a distinct account that the deluge of rain succeeded the tempest of fire. If we turn to the Norse mythology we find in the Voluspa, as it appears in the elder Edda, a description of the time when the conflict was taking place between Odin and Surt, just as we saw in the Greek the battle between Jove and Typhœus.

Surt from the South comes
With flickering flame.
* * * *
Then arises
Hlin's second grief,
When Odin goes
With the wolf to fight,
And the bright slayer
Of Beli with Surt.
* * * *
The sun darkens,
Earth in ocean sinks,
Fall from heaven
The bright stars.

* Theog., 841.
† "Mythology of the British Druids," p. 226.

Fire's breath assails
The all-nourishing tree.*
Towering fire plays
Against heaven itself.
She† sees arise
A second time
Earth from ocean,
Beauteously green,
Waterfalls descending.‡

The younger Edda also in its version speaks of Heimdal's fight with Loki (a variant of the other tale), and says, "Thereupon Surt flings fire over the earth, and burns up all the world." A man named Lifthraser and a woman named Lif were preserved from the effects of the conflagration by being hidden in Hodmimer's hold, and "from these are the races descended." In the dialogues of Plato§ we find that the Greek lawgiver Solon was told by the priest of Sais in Egypt, six hundred years before Christ, that the deluge of Deucalion and the earth being burnt up by the fall of Phaethon from the chariot of the sun related to actual events. He said, "This has the form of a myth, but really signifies a declination of the bodies moving around the earth and in the heavens, and a great conflagration of things upon the earth." Let us turn from these European stories—Keltic, Greek, and Norse—to the narratives of simpler peoples. The Chinese have a triad of gods named Yu, Yih, and Tseih. The deluge was covering the whole earth, when its course was stayed by Yu opening up nine channels for the water, while Yih opened up the forests with fire. So in the Mahabharata, the great epic of India, there is a description of Aurva the Rishi, who produced from his thigh a devouring fire, which cried out with a loud voice, "I am hungry; let me consume the world." The various regions were soon in flames, when Brahma interfered to save his creation, and gave Aurva an abode under the ocean, where he dwells as the submarine fire.‖ If now we leave Europe and Asia, and journey to South America, again the legend appears. The Tupi Indians of Brazil tell us the following: "Monau, without beginning or end, author of all that is, seeing the ingratitude of men, and their contempt of him who had made them joyous, withdrew from them, and sent upon them *tata*, the divine fire, which burned all that was upon the surface of the earth. He swept about the fire in such a way that in places he raised mountains and in others dug valleys. Of all men alone, Irin Magé was saved, whom

* Ygdrasil, the life-tree.
† *She* is the Vala, who is seeing the vision.
‡ "Edda Sœmundar Hinns Frôda," p. 10.
§ Timæus, xi., 517.
‖ Dowson's "Hindoo Mythology."

Monau carried into the heaven. He, seeing all things destroyed, spoke thus to Monau: 'Wilt thou also destroy the heavens and their garniture? Alas! henceforth where will be our home? Why should I live, since there is none other of my kind?' Then Monau was so filled with pity that he poured a deluging rain upon the earth, which quenched the fire, and flowed on all sides, forming the ocean, which we call *parana*, the great water."* If we travel from Brazil thousands of miles north to the tribes of British Columbia, the Tacullies, they inform us that when the earth had been made, and "became afterwards peopled in every part, it remained until a fierce fire of several days' duration swept over it, destroying all life with two exceptions. One man and one woman hid themselves in a deep cave in the heart of a mountain, and from these two the world has since been re-peopled."† The natives in the vicinity of Lake Tahoe ascribe its origin to a great natural convulsion. There was a time, they say, when their tribe possessed the whole earth, and were strong, numerous, and rich; but a day came when a people rose up stronger than they, and defeated and enslaved them. "Afterwards the Great Spirit sent an immense wave across the continent from the sea, and this wave engulfed both the oppressors and the oppressed, all but a very small remnant. Then the taskmasters made the remaining people raise up a great temple so that they of the ruling caste should have a refuge in case of another flood. . . . Half a moon had not elapsed, however, before the earth was again troubled, this time with strong convulsions and thunderings, upon which the masters took refuge in their great tower, closing the people out. The poor slaves fled to the Humboldt River, and, getting into canoes, paddled for life from the awful sight behind them, for the land was tossing like a troubled sea, and casting up fire, smoke, and ashes. The flames went up to the very heavens, and melted many stars, so that they rained down in molten metal on the earth, forming the ore that white men seek."‡ The Indians of Utah and California have legends of a time when the sun-god came too near the earth, and scorched the people with his fierce heat. The god Tawats determined to deliver humanity from this great trouble, so he came to "the brink of the earth, and there watched long and patiently, till at last, the sun-god coming out, he shot an arrow at his face. The fierce heat consumed the arrow ere it had finished its intended course; then another arrow was sped, but that also was consumed; and another, and still another,

* Brinton's "Myths of the New World," p. 227.
† Bancroft's "Native Races," vol. iii., p. 98.
‡ Bancroft, vol. iii., p. 89.

till only one remained in his quiver: but this was the magical arrow that had never failed its mark. Tawats, holding it in his hands, lifted the barb to his eye and baptised it in a divine tear. Then the arrow sped and struck the sun-god full in the face, and the sun was shivered into a thousand fragments, which fell to the earth, causing a general conflagration. [Here perhaps I may be allowed to call attention to the exquisite beauty of this poetical idea in the mind of a savage—the arrow of deliverance was powerless till touched with the tear of divine pity.] Then Tawats, the hare-god, fled before the destruction he had wrought, and as he fled the burning earth consumed his feet, consumed his body, consumed his hands, and his arms. All were consumed but the head alone, which bowled across valleys and over mountains, fleeing destruction from the burning earth, until at last, swollen with heat, the eyes of the god burst, and the tears gushed forth in a flood which spread over the earth and extinguished the fire."* In this story we have again the deluge of waters succeeding the great fire and extinguishing it. The Yurucares of the Bolivian Cordilleras and the Mbocobi of Paraguay all attribute the destruction of the world to a great conflagration which swept over the earth, consuming everything living except a few who took refuge in a deep cave.†

These tales, with all their wonderful series of coincidences, would have little except general interest for us were it not for the fact that the "fire and water" legends of disaster are repeated very clearly in New Zealand and in the islands of Polynesia. The most purely mythical versions are connected with the great hero Maui, and his feats for the benefit of mankind. He was desirous of obtaining the boon of fire for the use of the human race, so he went to his divine ancestress, the goddess of fire, Mahuika, to procure it.‡ It is unnecessary to repeat the whole of the tradition, which can be found in Grey's "Polynesian Mythology," White's "Ancient History of the Maori," and several other books,§ but the end of the legend deserves special notice. After Maui had obtained by artifice all the fire in the possession of the goddess, she became enraged and pursued him. "Then out she pulled the one toe-nail that she had left, and it too became fire, and as she dashed it down on the ground the whole place caught fire. And Maui ran off and made a rush to escape, but the fire followed hard

* "Popular Science Monthly," October, 1879, p. 799.

† Brinton's "Myths of the New World," p. 217.

‡ The Moriori version of this name—namely, "Mauhika"—seems more correct, as it suggests an etymology: *mau*, enduring; *hika*, to kindle fire by friction.

§ The Polynesian fire-getting legends are to be found compared in Trans. N.Z. Inst., vol. xx., p. 369.

after him, close behind him; so he changed himself into a fleet-winged eagle, and flew with rapid flight, but the fire pursued and almost caught him as he flew. Then the eagle dashed down into a pool of water; but when he got into the water he found that almost boiling. The forests just then caught fire, so that he could not alight anywhere, and the earth and the sea both caught fire too, and Maui was very near perishing in the flames. Then he called on his ancestors Tawhiri-ma-tea and Whaitiri-matakataka to send down an abundant supply of water, and he cried aloud, 'Oh, let water be given to me to quench this fire that pursues after me,' and lo, there appeared squalls and gales, and Tawhiri-ma-tea sent heavy lasting rain, and the fire was quenched; and before Mahuika could reach her place of shelter she almost perished in the rain, and her shrieks and screams became as loud as those of Maui had been when he was pursued by the fire: thus Maui ended this proceeding. So was extinguished the fire of Mahuika, the goddess of fire."* Here we have plainly the story of the earth being swept by fire and the forests consumed, followed by a deluge of water which extinguished the flames. This is the North Island legend; but the South Island priests of the Ngaitahu say, when speaking of the deluge, that at the same time was "the fire of destruction."† Colenso gathered, half a century ago, information from old chiefs, one of whom (from the East Coast, North Island) said, "Anciently the land was burnt up by the fire of Tamatea," when all things perished. Another, a chief of the Ngatiporou, of the East Cape, said that "all the moas perished in the fire of Tamatea."‡ Now, as we know that the moa (if by "moa" is meant the *Dinornis*, which I doubt) did not perish by fire, the inference is that this "fire of Tamatea" was probably a legend brought with them from afar, and localized. I have just recovered an interesting legend not yet published. It is as follows: "The descendants of Tarangata were the parents of Fire. He conceived the idea that he was destined to become the conqueror of the world. He protruded his tongue to lick up Water, thinking he could consume it all. Then came forth the great Wave to do battle with him. The one shot forth his tongue, the other did the same on his part. Aha! The name of the battle was Kaukau-a-wai. Then, then indeed was the power of Water exhibited. Aha! This was the defeat of Fire. It flew; it retreated; it was conquered

* Grey's "Polynesian Mythology," p. 30, ed. 1885.

† White's "Ancient History of the Maori," vol. i., p. 181.

‡ See Trans. N.Z. Inst., vol. xii., p. 81. The Tamatea mentioned is, however, almost certainly not the Tamatea of the tribe Ngatikahungunu, but probably the ancient deity mentioned by Wohlers in Trans., vol. vii., p. 6.

by Water. Before all was over, however, everything on earth had melted." The story of Maui having procured fire from celestial sources, and in doing so setting the world in flames, is the most widely distributed of all the Polynesian legends. The Mangaian (Cook Islands) version says that Maui resolved to be revenged for his trouble by setting fire to his fallen adversary's abode. In a short time all the nether world was in flames, which consumed the fire-god and all he possessed. Even the rocks cracked and split with the heat: hence the ancient saying, "The rocks at Orovaru are burning," equivalent to saying, "The foundations of the earth are on fire."* In Hawaii (Sandwich Islands) was preserved a distinct tradition that, on account of the wickedness of the people then living, the god Tane destroyed the world by fire, and afterwards organized it as it is now, the first man of the new race being called Wela-ahi-lani (Burning fire of heaven).† They have also a distinct tradition of the watery deluge.

Before leaving Polynesia, we may also notice that the Maoris speak of the deluge as "the overturning of the world." So the Ngaitahu relate that "Puta was the cause of the land being turned upside down,"‡ and the flood spoken of in the legend of Tawhaki, when the earth was overwhelmed with the waters, is called "the overturning by Mataaho."§ Now, the Greenlanders have the same expression as this. They are very much afraid of certain spirits called Inguersoit, who are supposed to be the souls of those people that died when "the world was turned upside down" in the days of the deluge. They are thought to have become flames of fire, and to have found shelter in the clefts of the rocks.‖

Having thus collected a certain number of facts as material for reasoning upon, let us consider if they contain any material worthy of study. Of course, when I speak of facts I do not allude to the substance of the stories as being facts, but to the convergence of certain lines of tradition. The first point to consider is the truthfulness of the idea contained in the old legends. Are they sheer, profitless lies, or are they merely veils for the truth? That they are lies, in the sense of being made with the intention to deceive, I do not think possible. The field for lying is so vast and originality so rare that I do not think it reasonable to suppose that pure false-

---

* "Myths and Songs of the South Pacific," by the Rev. W. Wyatt Gill, LL.D., p. 56.

† Fornander's "The Polynesian Race," vol. i., 63.

‡ White's "Ancient History of the Maori," i., 181.

§ In Grey's "Polynesian Mythology" (edition 1885) this is translated "the overwhelming of the Mataaho." It is a mere clerical error for "overturning," as can be seen by reference to the Maori text, p. 47.

‖ Crantz, vol. i., p. 208.

hoods with identical incidents would have sprung up in a hundred different places, and continue to agree with each other in their repetitions over vast spaces of time. The next hypothesis is that they are religious parables. It will be found that in almost all tales of the great ancient catastrophe, whether of fire or water, the notion of its having been a punishment for human sin is very prominent. Not only in the Biblical account, but in heathen traditions, it is said that men grew evil. Thus, in the Teutonic legend, that of the Scandinavian Voluspa which I before quoted, we find that before the earth was burned, and before its re-emergence from the waters, the time was one of brothers fighting against each other, cruelty and luxury reigning. "The age of axes, the age of lances, in which bucklers are cleft, . . . the age of 'north winds,' the age of fierce beasts, succeeds before the world falls to pieces. . . . Not one dreams of sparing his neighbour."* The Druid tells us that it was "the profligacy of man" that provoked the deluge and the conflagration. The Maori says that before the deluge "Man had become very numerous on the earth. Evil prevailed everywhere." The Hawaiian relates that the earth was destroyed by fire on account of the evil conduct of its inhabitants. The Brazilian describes "the ingratitude of men and their contempt for him who had made them." The tale is everywhere the same: a few are hidden from the fire in a great cave, or escape in a canoe from the overwhelming flood, to become the parents of a new race. If we grant that the stories had a religious origin, that the flood and fire were believed to be sent as punishments for sin, we may then ask, In what way was the tradition transmitted? Was it originally a legend handed down through many centuries to the descendants of those who really experienced the calamity in a certain locality? If so, it must be of stupendous antiquity, since the story is the property of ancient Briton, Scandinavian, Greek, Hindustani, Chinese, North and South American Indians, and Polynesian. The children of that one primitive people which experienced the flood must have differentiated into all these extremely foreign tribes. A far more probable theory is that the story, the property of one people, has been diffused to the others by communication. This, too, would necessitate a great antiquity; but for such antiquity there is good evidence. The more study one gives to the races of men the more impressed the mind becomes with the necessity for great spaces of time in which the drama even of *man's* life on earth can be played. Long periods are necessary for even the most simple phases of human existence

* Ida Pfeiffer's "Visit to Iceland," p. 333.

to develope and play their part. I do not fear at the present day to shock the sensibilities of others by such a claim, for a champion of the orthodox, Professor Sayce, has stated that he considers that human beings have communicated with each other by means of articulate speech for at least forty thousand years. And this is a very mild estimate compared with what some anthropologists demand. If, then, we allow six thousand years for all recorded history (much even of that being mythical), we have behind, in the darkness of unrecorded ages, thirty-four thousand years of which we know absolutely nothing except geologically. Time is here for the growth and decadence of great peoples, for endless wanderings, tradings, wars, captivities, and, in fact, an infinite variety of circumstances before which the mind falters. It is quite possible, nay, even probable, that in that far-off unknown time there were means of communication as to language and tradition of which we now have no conception, and that legend and story may have passed from race to race during epochs since which the very configuration of the earth's surface has had time to change.

Thus, then, we have considered three theories for the origin of the "destruction" legend: that it was pure lying, evolved similarly in many places at once; that it was a religious story (record or parable) handed down from a people which differentiated into many alien races; or that it was a tale which, issuing from one source, flowed by intercommunication among people widely separated in regard to locality and ethnic character. There yet remains another explanation, which seems to me to be the most probable of all—viz., that it belongs to the class of legends named by Tylor "myths of observation." These are mainly scientific discernments, distorted by imperfect observation, and affected by the primitive superstitions and dim perceptions of cause and effect which mark the simple mind of the barbarian. He sees, as the trained scientist sees, the facts of nature, and, unable to reason inductively, he deduces some false conclusion. He notices huge bones left uncovered by a landslip, or lying in a cave. Thence arises the idea that these are the bones of giants, and it is not long before around the incident are grouped all the accompaniments of myth—the war between the gods and giants, &c. The Siberians have often found bones, teeth, and other remains of mammoths partly exposed in river-banks or cliffs. They supposed, from seeing the remains thus half-buried in the ground, that these were the *disjecta membra* of some burrowing animal. The Chinese of the North call it *fen shu*, the "digging-rat." Soon arose legends of the creature's habits: the Yakuts and Tunguz have seen the earth heave and sink as a mammoth bored

underneath. In the Chinese Encyclopædia of Kang-hi it is described as like "a rat in shape, but as big as an elephant; it dwells in dark caverns, and shuns the light." Rhinoceros horns brought to Europe by ancient travellers were supposed to be claws of griffins, those great four-footed birds with claws like lions, spoken of by Herodotus and Ctesias. The Siberians also think that the fossil horns of the rhinoceros are the claws of an enormous bird, and thence has grown a myth that monstrous birds in olden times fought with the ancestors of men. "One story tells how the country was wasted by one of them, till a wise man fixed a pointed iron spear on the top of a pine-tree, and the bird alighted there and skewered itself upon the lance."* This legend is especially interesting, because it suggests the origin of some of our New Zealand stories concerning the great man-eating bird. The Rev. Mr. Stack relates a legend from the South Island, stating that a gigantic bird of prey had "built its nest on a spur of Mount Tarawera, and, darting down from thence, it seized and carried off men, women, and children, as food for itself and its young; for, though its wings made a loud noise as it flew through the air, it rushed with such rapidity upon its prey that none could escape from its talons. At length a brave man called Te Hau-o-Tawera came on a visit to the neighbourhood, and finding that the people were being destroyed, and that they were so paralysed with fear as to be incapable of adopting any means for their own protection, he volunteered to capture and kill this rapacious bird, provided they would do what he told them. This they willingly promised, and, having procured a quantity of manuka saplings, he went one night with fifty men to the foot of the hill, where there was a pool 60ft. in diameter. This he completely covered over with a network of saplings, and under this he placed fifty armed men armed with spears and thrusting-weapons, while he himself, as soon as it was light, went out to lure the pouakai from its nest. He did not go far before that destroyer espied him, and swooped down upon him. Hautere had now to run for his life, and just succeeded in reaching the shelter of the network when the bird pounced upon him, and, in its violent efforts to reach its prey, forced its legs through the meshes, and, becoming entangled, the fifty men plunged their spears into its body, and, after a desperate encounter, succeeded in killing it."† White also relates that the fairy people, the Nuku-mai-tore, were greatly troubled by the visits of a huge flesh-eating bird. It was killed by the hero Pungarehu;

* Tylor's "Early History of Mankind," p. 310.
† Trans. N.Z. Inst., vol. x., p. 64.

MARINE BIOLOGICAL LABORATORY WOODS HOLL LIBRARY

and they found round the cave in which the creature had lived bones of human beings strewn about.* Now, it is exceedingly probable that the Maoris, seeing the huge bones of the *Dinornis* lying on the surface, as we even now find them (when uncovered?), constructed on the immensity of the remains a myth about a monstrous man-eating bird, unaware that the *Dinornis* was wingless. It is improbable that the remains of *Harpagornis*, comparatively scarce and unremarkable, should have suggested the myth. In the ancient world the discovery of fossil bones often either originated or became the illustrations of myth, just as Marcus Scaurus brought to Rome from Joppa the bones of the monster prevented by Perseus from devouring Andromeda, and as the rib-bone of the whale still preserved in St. Mary Redcliffe Church is supposed to have belonged to the Dun Cow slain by Guy, Earl of Warwick. Numberless such instances could be cited if necessary.

On the other hand, there are myths of observation in which, probably, the legend is not so much an accretion to the natural fact as a slightly altered transmission of actual record. The savage tribes of Brazil tell of the Curupira, an enormous monkey, covered with long shaggy hair, and with a bright-red face. No such animal now inhabits Brazil; but geologists say that in the Post-pliocene period such a creature existed in that country, and may, possibly, have lived down to the time when man came into being. A tradition has been preserved by Father Charlevoix,† from North American sources, concerning a great elk. He says, "There is current also among the barbarians a pleasant enough tradition of a great elk, beside whom others seem but ants. He has, they say, legs so high that 8ft. of snow did not embarrass him, his skin is proof against all sorts of weapons, and he has a sort of arm which comes out of his shoulder, and which he uses as we do ours." Mr. Tylor, speaking of this legend, says, "It is hard to imagine that anything but the actual sight of a live elephant can have given rise to this tradition. The suggestion that it might have been founded on the sight of a mammoth frozen with his flesh and skin, as they are found in Siberia, is not tenable, for the trunks and tails of these animals perish first, and are not preserved like the more solid parts; so that the Asiatic myths which have grown out of the finding of these frozen beasts know nothing of such appendages. Moreover, no savage who had never heard of the use of an elephant's trunk would imagine from a sight of the dead animal, even if its trunk were perfect, that its use

* White's "Ancient History of the Maori," vol. ii., p. 33.
† "History of New France," vol. v., p. 187.

was to be compared with that of a man's arm." I may add to Mr. Tylor's remark that "the beast with a hand" is a well-known ancient name for the elephant, and that in the island of Java (west portion, Sunda) the elephant is called "liman," a word derived from *lima*, the common word for "hand" and "five" in Polynesia.

Thus, then, we have the myths of observation divided into two classes: one in which the natural object becomes suggestive and gathers myth—for instance, the discovery of large bones giving rise to the story that "there were giants in those days," the war of the Titans, &c.; the other class is that wherein has perhaps been kept a dim record of events once observed, but which without the tradition would have been forgotten. If the stories both of the watery deluge and of the destructive fire are not religious dramas portraying the earthly punishment of the wicked, to which class of the myths of observation do they belong? I am strongly inclined to think that they do not belong to the series of tales which have preserved the memories of things which once existed, or circumstances that really happened. They are not like those legends in which is probably kept alive the memory of the elephant among American Indians or of the great anthropoid ape in Brazil. They are more likely to be partially-imperfect scientific observations. Thus: the savage sees, as we see, sea-shells on the top of a mountain, and he argues as we do, "This place was once covered with water." But he does not go on, as the geologist does, gathering fact after fact, and deducing therefrom the knowledge that different portions of the earth's surface, now solid land, were once submerged, and have been upheaved. The untrained observer's imagination goes to work and pictures a sudden and dreadful catastrophe—in fact, a deluge. But what should such a deluge be for? What could such a drowning quantity of water have been needed for but to extinguish a world-destroying flame? Around him his watchful eye notices other rocks which have been subjected to the action of fire. This is not to be denied, for he can probably see in many places lava-flows actually in process of being converted into stone, and those who think that the uneducated mind is incapable of recognizing similar action in the plutonic rocks know little of the acute powers of reasoning (in some directions) possessed by primitive men. Here is the water-worn rock, so once there was a deluge; here is the fire-fused rock, so once there was a conflagration in which the whole earth was on fire. Given this idea, started in two or three places, however widely separated, and interchange of thought during the immense spaces of prehistoric time would well account for the dissemination of the myths.

I believe that the Maoris have many myths of observation

not of this kind, and to these I hope next year to call your attention; but the particular class of legends relating to the deluge has probably sprung from suggestions inspired by keen eyes and inquiring brains seeking to account for geological puzzles.

There is one thing which, it is only honest to say, troubles me and prevents my wholly accepting the "observation-myth" explanation. I cannot help thinking that at some exceedingly ancient date the world, or a large part of the then known world, was really visited by some great catastrophe. Major-General Schaw lately gave us his interesting paper on the Great Ice Age,* but neither in his paper nor, curiously enough, in the discussion that followed was mention made of the *suddenness* with which the climatic alteration was effected. The mammoths whose remains have been exhumed in thousands in Siberia were victims of some sudden calamity. In full vigour of life they were frozen up and preserved. So also with the vegetable remains now to be found in the polar regions. The stumps of magnolias, walnuts, limes, vines, and mimosas (which prove a luxuriant flora and almost tropical climate to have existed in Greenland and Spitzbergen) had not time to decompose and rot before the Terrible Age of the world set in.† That the calamity was accompanied by great cold appears to be taught by one of the oldest religious books in the world, the Zend Avesta of the Parsis. In this book the first Fargard of the Vendidad describes the creation of the world by the great spirit Ahura Mazda; and the second Fargard speaks thus: "The Maker, Ahura Mazda, of high renown in the Airyana Vaego, by the good River Daitya, called together a meeting of the celestial gods. . . . And Ahura Mazda spoke unto Yima, saying, 'O fair Yima, son of Vivanghat, upon the material world the fatal winters are going to fall that shall bring the fierce foul frost; upon the material world the fatal winters are going to fall that shall make snow-

* See above, p. 513.

† As it was stated at the time this paper was read that the age of the luxuriant vegetation at the north pole was somewhere in the Tertiary period, and long antecedent to man's appearance on earth, I beg to be allowed to add the following quotation from a paper by the distinguished scientist, Sir Archibald Geikie, Director-General of the Geological Survey of Great Britain ("Smithsonian Report" for 1892): "There cannot be any doubt that after man had become a denizen of the earth a great physical change came over the Northern Hemisphere. The climate, which had previously been so mild that evergreen trees flourished within ten or twelve degrees of the north pole, now became so severe that vast sheets of snow and ice covered the north of Europe. . . . Such a marvellous transformation in climate, in scenery, and in inhabitants . . . is surely entitled to rank as a catastrophe in the history of the globe. It was probably brought about mainly, if not entirely, by the operation of forces external to the earth."

flakes fall thick even an *aredvi* deep on the highest tops of the mountains. And all the three sorts of beasts shall perish: those that live in the wilderness, and those that live on the tops of the mountains, and those that live in the bosom of the dale under the shelter of stables. Before that winter those fields would have plenty of grass for cattle; now, with floods that stream, with snows that melt, it will seem a happy land in the world—the land whereon footprints even of sheep may still be seen. Therefore make thee a Vara,' "* &c., the god instructing Yima how the remnant of men, cattle, seed, and other things might be preserved against the time of trouble close at hand. Whatever that trouble was, whether of fire, or water, or intense cold, or of the whole three in succession, the memory of such an evil time could never have coexisted in the legends of Europeans, Asiatics, American Indians, and Polynesians if those people then occupied the localities they now inhabit, since we know that no catastrophe has been universal. In such case we have to rely upon the theories either of common descent or of free interchange of traditions all round the world in prehistoric times.

ART. LXVII.—*Ceremonial Language.*

By EDWARD TREGEAR.

[*Read before the Wellington Philosophical Society, 8th August, 1894.*]

AMONG the islanders known as the fair Polynesians only those of one group have a distinctly-marked ceremonial language—that is, a language possessing words and expressions used in addressing superior or high-born persons. There are faint traces in other island-groups of this usage, but not sufficiently defined to be of much interest. In islands belonging to races dwelling in or near the Pacific there still survive ceremonial languages probably of great age—namely, in the islands of Java and Bali in the Malay Archipelago, in Ponape of the Caroline group, in Lifu of Melanesia, and probably in several others. Far-off Madagascar, linguistically connected with the Malays, also has a partially ceremonial language. These dialects of respect and reverence present peculiar features to the student, and, although the Samoan is the only local variety with strong claims on our attention, we must briefly consider the others, and notice their general principle before touching on the details of the Polynesian in particular.

There is in all nations and races a tendency to set apart

* Darmesteter's "Zend Avesta," vol. i., p. 15.

certain words or phrases as being *tapu*, or "prohibited," to the common or vernacular speech. We find it existing in modern tongues at the present day, and it takes form in two different ways. One is of interest grammatically: it consists of changing cases and numbers; the "*tutoîment*," the "thee-ing and thou-ing," of French and German marking different address to inferiors and intimates. In German we have the ceremonious plural for singular in verbs. In English the third person is more ceremonious than the first, as when Mr. Jones writes that "Mr. Jones presents *his* compliments," instead of "I present my compliments," &c. The plural "we" for "I" of royalty and editors is also a ceremonial use of grammar; so is the use of a title instead of the second person, as "I hope that *your Highness* will come," instead of "I hope that *you* will come." The other line of ceremonial usage is a thousand times more interesting: it is the historical form of ceremonial speech. It is perhaps best illustrated by a well-known example, that of the superposition of Latin words, through Norman French, upon the Teutonic dialect of our ancestors. We are told that in many ways this was noticeable: thus, the poor Saxons who had to take care of animals for the lordly new-comers kept the old Saxon words cow, sheep, calf, deer, &c.; but the name of the cooked meats became Norman—beef, mutton, veal, venison, &c.—because the common people did not use these delicacies. For many generations Norman French was the Court language; and on the revival of classical learning at the time of the Renaissance the English tongue was still further enriched and added to by words of Latin derivation. This remains at the present moment the inflated and more stately form of our general speech. When Dr. Johnson corrected his sentence about a certain drama, "It has not wit enough to keep it sweet," into "It has not sufficient vitality to preserve it from putrefaction," he was merely changing from the short plain words of Saxon into the fuller Latin language of ceremony. This would have little scientific interest for us if we did not observe that herein is preserved a historical record—a record that, if all the documents in the world were burnt to-morrow, would assure the linguist that the English had once been conquered by a people speaking a Latin dialect. It is in this direction, and in this direction alone, that a study of a ceremonial language is of living interest; and it is in the hope of being able to trace some historical points, or to prove that there are no such historical points, that I venture to direct your attention to the ceremonial languages to be found south-east of the continent of Asia.

In Java we have a full language of ceremonial in actual use, and apparently of some antiquity; moreover, it proves,

exactly as the English proved, to be of historical interest. In Java three languages are spoken: the first is that of the common people; this may be considered as a dialect of the Malay, or perhaps the Malay may be considered a dialect of Javanese. It has many words not used by the Malays; but even these perhaps may be considered as relics of the original speech better preserved in Java than in Malacca or the outlying islands of the Archipelago, for Java was the centre of a high civilization for several centuries. The great island abounds in ruined cities, whose magnificent architecture is in ruins, and sometimes overgrown with tropical verdure—the home of the serpent and the wild beast. In those splendid temples were preached the great Indian religions of Brahma and Buddha till these went down before the all-conquering faith of Islam. The vulgar tongue bears internal evidence of these great waves of conquest, and the Sanscrit and Pali of India are mixed with the Moslem Arabic in the vernacular of the Javanese. The second language is the Kawi, the priestly tongue in which all documents and poetry are written; it is a mixture of Javanese and Sanscrit. The third language is the Basa-Krama, words meaning "polite" (in contradistinction to the *ngoko*, or vernacular), but both are from Sanscrit, being *krama*, "order," and *bhasa*, "language." It appears to be a thoroughly made-up dialect, formed by taking words not in common use and engrafting foreign words so as to avoid familiar native expressions. Some of these are taken from Malay or Sundanese, some from Sanscrit, others by corrupting the words of the vernacular. But, despite of research, there is not the slightest internal proof that the ceremonial language is older than the vernacular: in fact, the reverse is the case. It is evident that the Sanscrit and Arabic are late arrivals embroidered on to the simple web of the native speech, just as Norman French was worked over Saxon English. Precisely, so far as we can learn, was this the case also in Bali and the other islands. The ceremonial languages are recent growths, products of civilization, probably due to conquest, or else from the acceptance of overwhelmingly dominant religions.

If we can show something of the kind in Samoa it will prove of great historical interest. If we can show that the Samoan ceremonial language consists even in part of foreign words, or of words not found in common use anywhere in Polynesia, we shall have made a distinct advance. For my own part, I regret to say that I can do no such thing—that I do not perceive any indication whatever showing conquest or religious supremacy by a foreign power, and that therefore the inquiry is historically void. But it is not scientifically void if we can show the negative side, and prove that in this direction at least search is useless.

In the ceremonial language of the Samoans we have a word *fofoga*. A common man's eye is *mata*, a chief's eye is *fofoga;* a common man's nose is *isu*, a chief's nose is *fofoga;* a common man's mouth is *gutu*, a chief's mouth is (still) *fofoga*. This seems a rather inconvenient and indefinite style of address, unless we translate *fofoga* as feature, instead of nose, mouth, &c. When an ordinary man bathes it is *ta'ele;* when a chief bathes it is *'au'au*, to swim about, or *fa'a-malu*, to cool oneself. For the common word *sau*, to come, we have the respectful *maliu-mai* to a head-man, *susu-mai* to a great chief, *afio-mai* to the greatest chiefs. When a peasant eats it is *'ai;* when a chief eats it is *taumafa*. When a commoner coughs it is *tale;* when a chief coughs it is *male*. The oration of an ordinary person is *lauga;* a chief's address is *afioga*. The ordinary word for sickness is *ma'i;* the chief's word is *gasegase*, weariness. When a plebeian lies down it is *taoto;* when a chief lies down it is *falafalana'i*. Before a chief a thing is not "burnt" (*susunu*); it is *fa'a-vela*, "made warm." The will or intention of a common man is *loto;* but a chief's will is *finagalo*. These may serve as sufficient to exemplify the subject.

There are three things to consider in analysing these chiefs' words: (1.) Are they foreign? (2.) Are they ancient? (3.) Do they stand in the same relation to Samoan as Basa-Krama does to Javanese, or Norman French did to English?

The answer is "No" to every one of these questions. As to their being foreign, although the etymology is, naturally enough, not clear at first sight, they are very certainly true Polynesian words, most of them true Samoan words. Taking the words which are not evidently Samoan, and whose meanings are not mere evasions (such as *gasegase*, wearied, instead of *ma'i*, sick), we can trace them with ease. *Fofoga*, the chief's word for nose, eye, mouth, &c., is in the Tongan *fofoga*, the head or face applied to chiefs, and probably the Tahitian *hohoa* form, likeness. From the chiefs' words meaning "to come"—viz., *maliu-mai*, *susu-mai*, and *afio-mai*—we may eliminate the *mai*, as it only means "hither." *Maliu* is a pure Polynesian word. It is found in Hawaiian—*maliu*, to attend to one, to listen to a request, to turn towards one and be gracious. Thus, *maliu-mai* means "be gracious hither," a lofty way of asking a chief to come. *Susu* is the Hawaiian *hu*, to come, to heave in sight, as a ship. *Afio* is a royal word in Tahiti; and in Maori means to wind round, to turn one thing round another, so that *afio-mai* is a form of "turn hither." *Taumafa*, the chief's word "to eat," is the Maori *taumaha*, a thank-offering to the gods, and the Tahitian *taumaha*, an offering of food to the gods. While the common man's cough is

tale, the chief's cough is *male*, the latter word being the general Polynesian for "cough," the Maori *mare*, the Tahitian *mare*, the Hawaiian *male*, &c. *Finagalo*, a chief's will or desire, is the Maori *hinengaro*, the bowels, affections, feelings; Tahitian *hinaaro*, desire, affection; Tongan *finagalo*, the mind (applied only to the king); Futuna *finagaro*, the mind, the will, &c. *Fetalai*, to speak of a high chief, is the Tongan *fetalai*, to converse, to discuss, where *fe* is the reciprocal particle and *tala* means to tell, to speak of, just as it does in Samoan. All the other words could be similarly dissected or compared if worth the trouble. There is not the slightest reason for going outside Polynesia proper to find the equivalents of the words of the chief's language in Samoa. They may be remotely connected with Malay, but Polynesian is not a derivative from Malay, or so modern scholars believe; the conclusions are rather the other way.

As to the local antiquity of the chiefs' words, the oldest legendary poem yet collected in Samoa is "The Genealogy of the Sun," and of this the learned translator, the Rev. Mr. Pratt, remarks, "The entire absence of the chiefs' language is one mark of the age of the legend." Thus it would appear that the chiefs' language is of modern growth. These two ceremonial languages (of Java and Samoa) are entirely distinct, and there is no pretence for believing them related, or that the Samoans brought their notion of a courtly language from the Malayan Archipelago. If the ancestors of the Samoans ever dwelt in or passed through the Malayan Archipelago (as they almost certainly did) they must have done so at a period far antecedent to the time when the Javanese invented their courtly language, because that is a thing of comparatively modern growth.

As a mere suggestion, I consider that the Samoan chiefs' language probably arose from the common Polynesian custom of making certain words *tapu*, or "prohibited," if they form part of a chief's name. A great many words might after a time become prohibited to inferiors, and only used before men of high rank; thus gradually a court language might spring up. I trust that I have shown that from a scientific point of view the chiefs' language of Samoa is only of linguistic interest, and has no historical value whatever.

Art. LXVIII.—*The Modern History of a Block of Greenstone.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 12th November, 1894.*]

A few peculiar public occurrences of this present time (the middle of September, 1894) have set me a-thinking at almost a right angle—in a strange kind of way. But first, and very briefly, of the said occurrences, which are four in number: (1) The death of the Maori king, Tawhiao, at his own village in Parawera; (2) the death of Henare Matua, a chief of the Ngatipahoro family, an able and popular man, well known in the Native Land Courts, and at many public political Maori meetings, both far and near, with whom many of our early settlers have had extensive dealings; (3) the death at the same time (7th September) of a well-known and respected aged Maori of note, Noa Huke, for several years (1848–53) a useful and faithful Christian teacher of mine; and (4) his burial at Omaahu on the 18th September. These events, taken together, have produced within me "things unattempted yet in prose or rhyme," and, united, are the efficient cause of my writing this paper, as you may see.

(Here I quote from my old Maori-written relation:) "Of the huge stone: Many years ago this big lump of greenstone =*pounamu* was purchased from a European in Cook's Strait by the Ngatiraukawa Tribe there residing, and from that time it lay quietly in their possession until the death of Moses Tarapuhi.* When the Hawke's Bay tribe (Ngatikahungunu) heard of his death they arose in a large body from these parts, as far as Porangahau inclusive, and travelled to Manawatu, and on to the west coast to Foxton, to the funeral; and while there the big greenstone was publicly brought forward and ceremonially placed and presented by the Ngatiraukawa Tribe to their visitors from Hawke's Bay, at the same time naming the said stone 'The Tears of Ngatiraukawa.'† On their visitors leaving, the big lump was put on board of a canoe, which was poled up the River Manawatu to Moutoa. From this village it was fetched by the Ngatipaka-

* Moses Tarapuhi was a chief of some note who had formerly, and for some years, resided in the Bay of Islands. A few years after I had settled in Hawke's Bay he and his wife, who had known me there, arrived here, and, after staying some time, went on to the west coast, near Foxton.

† "Ka tapaetia te tapae, 'Nga Roimata o Ngatiraukawa.'"

paka Tribe, and taken by them to the village Te Hautotara, on the Upper Manawatu, where it remained quietly for a long time, the admiration and wonder of all beholders. Some years elapsed, and then it was borne in a litter by Ngatipakapaka to Porangahau, and transferred to Henare Matua; and some time after it was handed over by Henare Matua to Te Harawira Tatere,* who had it carried to his village at Waimarama (near Cape Kidnappers), where it also remained for a long time in his possession, until finally it was taken by him and his people to Napier, to be sawn into slabs of proper thickness for the purpose of being afterwards cut up into fit portions for *meres* (or hand-clubs), after the fashion and taste of the Maoris, he, Te Harawira, having arranged with a white man in Napier to saw up the said block of greenstone for him; but from this time it became wholly lost to the Maori people." (Thus far the written relation by the Maoris.)

In the year 1878 the said block of greenstone was brought by Te Harawira to Napier, he having arranged with a European named James Rolfe, residing there in Emerson Street, to cut it up for him. Some time after, I, on hearing of this work, visited Rolfe's workshop to see the operation, and found him and his wife closely engaged in carrying on the work. It was a small room; two or three small saws were in brisk movement, worked by steam; and, though I stayed some time, and closely watched their cutting, they seemed to lack power, so that when I left I could not but believe, at the rate they were then going on, it would take a very long time to accomplish the intended work, their simple and almost improvised makeshift machinery wanting power.

In 1881 Rolfe, having some time before completed his task, and finding he could not get the owner and his friends to come to any satisfactory terms, brought the matter into Court before the Resident Magistrate; but on this occasion Rolfe was nonsuited, on the ground of insufficient evidence.

Two years after, in 1883, 19th February, the matter came again into Court, this time into the District Court, before Judge Hardcastle, when Mr. Lascelles was the solicitor for Rolfe, and Mr. Lee for Te Harawira.

Rolfe's amended claim (now) was for £190, for cutting up the said block of greenstone. In his statement he said that the block weighed about 3cwt.; that the agreement between himself and Te Harawira was for him to cut up the block into twelve cuts (or slabs), for which work £200 was to be paid by instalments. That on the next week Te Harawira called and

* In the law-courts, *infra*, he is named Orihau. Like many other chiefs, he bore two names.

paid him £10, as the first instalment, but that nothing had been paid since. It took him two months to make the first trial cut, and nine months to make eleven cuts. That he had eleven saws at work at one time by steam-power, ten to fourteen hours a day. When the work was finished, and after much talk with Te Harawira and his friends, a compromise was offered of £100 to be paid to him, together with half of the greenstone, and to this he agreed; but, after long waiting, no money was forthcoming. He had also offered to take the stone (slabs) as payment for his heavy labour, but this was refused.

Mr. Cooper, a watchmaker and jeweller of Napier, stated that he was acquainted with similar work—the cutting-up of greenstones—and 1s. per square inch was the usual charge; and, speaking from memory, those cut slabs of greenstone would each average about 24in. × 15in.

Te Harawira (the defendant), in his evidence, stated positively that no final agreement as to price had ever been arranged, and that the charge for cutting was far too high.

Mr. Lee, for defendant, held that no contract had ever been made, and that the charge was excessive.

The Judge took time to consider his sentence, and on the next day judgment was given for £150, and costs £14 3s.*

No money being forthcoming, in the following month (March) the bailiff took possession of the greenstone, under execution warrant of distress, and duly advertised for sale by auction on the 14th, at noon, "12 slabs greenstone; average weight 25lb. each."†

I happened to be in town on that day, and in passing by the auction-mart, and seeing some acquaintances standing at the entrance, I went up to speak with them, and then, for the first time, saw the said twelve slabs of greenstone inside on a table. So I went in; and soon after the sale began, when I purchased five slabs, and should have bought more had not my acquaintances expressed their wishes to get some also. The whole lot only realized £20 10s.‡

---

* *Hawke's Bay Herald*, 20th and 21st February, 1883.

† *Daily Telegraph*, 13th March, 1883.

‡ *Account Sales, Twelve Greenstones.*

No. 1 greenstone	..	*£1	0	0	No. 7 greenstone	..	£1	2	6
No. 2	„	..	0	10	0	No. 8	„	..	*2	5	0
No. 3	„	..	1	2	6	No. 9	„	..	1	5	0
No. 4	„	..	1	5	0	No. 10	„	..	*3	0	0
No. 5	„	..	*2	0	0	No. 11	„	..	1	12	6
No. 6	„	..	*2	15	0	No. 12	„	..	2	12	6

From which sum was deducted: Commission, £1 0s. 6d.; bailiff's charges, £3 13s.: leaving £15 16s. 6d. (From District Court records.) The slabs purchased by me are marked with a star.

Mr. William Broughton, from Renata's village at Omaahu, was present at the sale, and purchased one of the slabs. At this time the Maori king, Tawhiao, had recently arrived at Omaahu from Wellington, *via* Waipawa; and I, who had long known Mr. Broughton, gave him one of the slabs I had just purchased as a present to the Maori king, Mr. Broughton taking it away with him in his dog-cart. I should mention that I had been invited by Renata to attend the public meeting and banquet given by him at Omaahu on the following day.

The next day I went to Omaahu. A pretty full description of what took place there on that occasion was given in the Napier papers, from which I extract one sentence respecting the said slab of greenstone: "A big bell rang. Tawhiao came out of a large *whare* (Maori house), and was met by Renata, who, with a finished courtesy which would have done no discredit to a European host, took him by the hand and led him to the seat of honour in the tent, before which stood a large slab of greenstone, a present from Mr. Colenso."—(*Hawke's Bay Herald*, 16th March, 1883.)

Dinner over (which was a large one), "King" Tawhiao walked leisurely back to his tent and clan, carrying carefully his large greenstone prize closely laid across his breast. Kings, emperors, and mighty chiefs of other countries and peoples, both Christian and heathen, have often from time immemorial dined off gold plate, but I fancy no Maori chief before Tawhiao ever dined off a flat greenstone dish!—no doubt in his opinion, and in those of his ancestors, of far greater value than gold itself.

Subsequently I got three of them roughly polished on one side by our monumental stone- and marble-mason, Waterworth, who did not, however, readily undertake the work, as such a stone was well known to be very hard, and had not hitherto been worked by him.* Two of those slabs I show here to you this night; one of them, also, being an outer slab of the original block, is peculiarly worn and irregularly rounded on the outside, somewhat resembling some of those big abnormal lumps and nodules of limestone and of flint (pot-stones) found in chalk at Home, and like them in having a thick white incrustation closely investing.

And so it was that on my again visiting Omaahu in September, at the funeral of Noa Huke (as mentioned by me in my "Introduction"), being also the *first* time since that other public visit of mine in 1883, the place, the greenstones, the circumstances past and present, the men (including the

* I may mention his charge for so doing was £1 15s. for the first and £1 10s. each for the remaining two.

Maori "king," Noa Huke, Henare Matua, Renata Kawepo, Te Harawira, and others, chiefs of note, and prominent speakers and actors on that former occasion—*all* now *gone*), afforded ample themes for reflection during my solitary long drive back to Napier in a cab, and in pouring rain.

The New Zealand greenstone, called generally by the Maoris *pounamu*, of which, however, they have several varieties, each bearing its own proper name, has always been a prized article among them—indeed, of the highest value as a possession, as riches, as heirlooms, and as a commodity of barter. Many causes combined to make it such, principally its great usefulness among a people that knew not metals—whether manufactured as a weapon in war, as an implement in house- and ship-building, or as an ornament of personal decoration for their chiefs, to which must also be added its rarity (as to habitat), only now found in one known locality in the South Island, from which place it could only be obtained by great perseverance and courage, combined with skill, labour, cunning, and peril. And then, above all, was the ancient superstitious belief that it was a living animal, *ika* = fish, that could only be secured through the due and unbroken observance of many peculiar and wonderful incantations, charms, and prayers; and, when so acquired, the patient persevering labour and skill requisite in cutting it up and fashioning it symmetrically and suitably for use was really marvellous. I will here give two (out of many) old Maori relations I possess respecting the present habitat and mode of capture of greenstone. My first was written more than fifty-five years ago, and published (with other curious items) in the "Tasmanian Journal of Natural Science," vol. ii., in 1845 (my paper being dated January, 1843) :—

"The wind being light, we had Tuhua, or Mayor Island, in sight. This island appears to be of volcanic origin, and abounds in pumice, obsidian, slag lava, pitchstone, and other vitreous and volcanic substances. I use the word 'appear' in consequence of a curious relation which some years ago I received from an old priest residing at Tauranga, in the Bay of Plenty. I had been inquiring of him the place where, and the manner how, they in former days obtained the green jade or axe-stone for ornaments and weapons of war. In answer to my inquiry he asserted that this stone was both a fish and a god;* that it formerly lived at the Island of Tuhua, whither the priests (or *tohungas* = skilled men) of all the neighbouring tribes used to go to take it, which was done by diving, accompanied with several superstitious ceremonies in order to

* God = *atua*: better, perhaps, a demon, or supernatural or mysterious thing or personage.

appease its wrath, and to enable them to seize it without injury to themselves; but that suddenly it made the whole island, and the surrounding sea, its *cloaca maxima*, covering every place thickly with excrementitious substances, which still remain, and swam away to the Middle Island of New Zealand, where it has ever since resided, and whence they have been obliged to obtain it. I scarcely need add that those 'excrementitious substances' comprise the different volcanic matter with which the Island of Tuhua is now covered. Perhaps after-ages may verify the tradition related by the old priest, and bring to light the *soi-disant* god in a buried stratum of axe-stone" (*l.c.*, p. 215).

My second was written by an intelligent aged Maori of Hawke's Bay several years ago, who had collected the information in answer to my inquiries; and, as it is peculiar, I shall also give the Maori verbatim, with my free English translation:—

"To Colenso: greetings. I now despatch [to you] the information respecting the *pounamu*. Te Akapikitia asserts that this thing, the *pounamu*, is really a fish. (But I say, How did it become petrified?) Better, perhaps, is the statement made by a certain man of the Ngatimarau family, who returned from that place. His name was Hanita te Maero: but he is dead.

"Now, this is his relation: Whenever a man residing there has a great desire to go [and take *pounamu*], he first says to his wife to pound some prepared fern-roots to carry with him as food for the long journey thither [over lands with no inhabitants]. In his sleep at night he dreams, and on awaking at daylight he relates his dream. Then he says to his wife to give to him the prepared lump of beaten fern-roots; and this is then carefully wrapped up in leaves of kawakawa and kokomuka shrubs.* He then starts on his journey, first placing a succulent shoot of tutu† in one ear, and of kokomuka in the other ear. And he travels until he reaches Poutini;‡ there is Arahua, the water in which the *pounamu* dwells. Then at the fit time he dives, and, lo! there it is found lying. He then fastens on to it a prepared noose rope, and it is forcibly dragged out by those waiting on the bank of the water, and it lies on the ground. Then it is carried away to the village and worked up at leisure. The pieces of greenstone that are collected, cut up, and used by Europeans are not the same kind as those found in the water, or below in the very bed or bottom of the water. These [of theirs] are very common

---

* *Piper excelsum* and *Veronica salicifolia*.
† *Coriaria ruscifolia*.
‡ An old name for the greenstone.

pieces, found scattered on the land in places where they have been heated and dried by the sun.

"Further, it is constantly asserted in the fabulous stories of the tribes of these parts that the greenstone is truly a fish. (But how did it become hardened—stonified?) That fish, the greenstone, is said to have come to this land from abroad [far off on the other side]. On its first coming hither it made Tuhua [island], when the dark rocky barriers of tuhua [obsidian] grinned fiercely in defiance, showing their teeth; so greenstone kept off, floating away at a distance, and not coming near the shore until it reached the open space between Whareama and Motuairaka*—that is, to Takiritane. There also the teeth of those rocks showed themselves fiercely. Still floating away at a distance from land, it was finally drifted on shore at Kaikoura, where also is Poutini Arahua, the water in which lies this fish, the greenstone.

"Here is yet another relation [respecting it] by Himiona te Aka. When the men-workers of greenstone go thither, on arriving at the spot some remain on the shore [banks], and the man who has been prepared to dive goes [into the water], taking with him the end of the long rope, the other end being with the men on the bank. He dives and goes right down to shell-sand [to the beds of shell-fish], to the very bottom. He looks up above, lo! the greenstone pendent over and above him. Then he casts the rope prepared with a running knot,† and it is secured, and then [the greenstone] is dragged out and lies on the bank of the water. It is carried off on [their] shoulders in a litter to the village, and worked up; and when finished [they] go to dispose of [their] riches. Here ends the information [I have received] concerning the greenstone."

While the general meaning of these last-written communications may be understood by the English reader, there is much that remains unknown to him, partly owing to the different idiom, but mainly to the brief mention of, or merely allusions to, Maori matters, beliefs, customs, and habits, so well known to the Maoris themselves. And it would take some considerable time and much writing fully to explain all those allusions. Not unfrequently has a Maori relation of ancient doings, especially when containing brief notices or

---

* On east coast, near Castle Point.

† The same curious, rare, and highly descriptive term (*here-taniwha*) is used here that was used in the account given of the capture of the big and fierce *mako* shark (Trans. N.Z. Inst., vol. xxiv., p. 448). This further tends to show their fixed belief in the greenstone being a living creature; *ika* = a fish. The same name was also invariably given by the old Maoris to bitumen, which was only (and rarely) found in large abnormal black lumps on the sea-shore, and used by them as a prized masticatory.

hints of superstitious ritual observances, reminded me of a beautiful torso dug out of the earth, possessing but a small part of its pristine elegance of form and expression; but when the portions that are lacking can be supplied from classic tale, then all (as it were) is revealed. Even the apparently trivial circumstance of the man, when setting out on his journey to obtain greenstone, ceremonially placing the two sprigs of named shrubs in his ears, has a deep meaning; besides, some such simple observance, of using sprigs and branchlets and leaves of certain herbs and shrubs, was always made use of by the *tohunga* in all the various lustrations and charms and performances connected with the laws of the *tapu*—tending to show the natural simplicity of their more recondite or sacred actions. Moreover, similar shoots or sprigs of various and named British trees were also used by the Druids in their religious ceremonies, according to the Triads; and so by the Jews under the Levitical ritual were sprigs of hyssop.

ADDENDUM.

The Maori Relation referred to above.

"E koro, e Te Koreneho, tena ra ko koe. Tenei ka tukua atu te korero, o te pounamu. E ki ana a Te Akaipikitia: He ika ano tenei mea te pounamu. (A, he aha ra i maro ai?)

"Engari, pea, ta tetahi tangata o Ngatimarau, i hoki mai, i reira. Ko Hanita Te Maero tona ingoa; kua mate ia.

"Ko tana korero tenei: Ka hiahia te tangata o reira, ka kii atu ki tana wahine, kia patua he aruhe hei o mona ki reira. I te po ka moe. Moe rawa iho ia, e awhiawhi ana raua ko tetahi wahine i te po, wahine pai o te poo. Oho ake te ao, ka korero, taku moe. E awhiawhi ana maua ko Mea.

"Ka kii atu ki te wahine, kia homai te pooi aruhe. Ko nga takai o te pooi aruhe, he kawakawa, he kokomuka. Ka haere, ko te pitau tutu, ara ko te rito o te tutu, ki tetahi taringa, ko te kokomuka ki tetahi taringa. Ka haere, ka tae ki Poutini, kei reira a Arahua, te wai i takoto ai te pounamu. Ka tae, ka ruku; na, e takoto ana; ka herea te taura; ka tooia e nga mea i uta; ka takoto ki uta. Ka mauria ki te kainga, ka mahia. Ko nga pounamu e mahia nei e te pakeha, ehara i te mea no roto no te wai, no raro ranei no whakatakere rawa o te wai; kaore, no uta noa nei, no te wahi whitinga ra nei.

"E kiia ana, e nga korero parau a nga iwi nei: He ika tonu te pounamu. (He aha ra i maro ai?) Haere mai ana taua ika nei, te pounamu, i raawahi, tae rawa mai ki Tuhua, e pakiri atu ana nga niho o te paretao o Tuhua. Haere tonu i waho, tarewa tonu i waho, kaore i tata mai ki uta; tae rawa atu ki waenganui o Whareama, o Motuairaka, ara ki Takiritaane,

e pakiri mai ana nga niho o tena kowhatu. Tarewa haere tonu i waho, pae rawa atu ki uta, ko Kaikoura; kei reira hoki a Poutini Arahua, te wai i takoto ai te ika nei te pounamu.

"Tetahi korero ano a Himiona te Aka. Ka haere nga tangata mahi pounamu ki reira. Ka tae atu, ka noho etahi i uta; ka haere te tangata mo te ruku, ka riro ano tetahi pito o te taura i a ia, tetahi pito ki nga tangata i uta. Ka ruku, ka tatu ki te onepipii, ka titiro ake whakarunga, e! e tarewa iho ana i runga ake i a ia; katahi, ka herea taniwhatia, ka mau; ka mea, ka hutia, ka takoto ki uta; ka amohia ki te kainga, ka mahia, ka oti; ka haere i te kaitaonga. Ka mutu te korero mo te pounamu."

"He Waiata tenei mo Poutini Arahua.—'Ehara hoki au i te tangata kite i a Poutini i Arahua* ra, ee, i te wai ra i takoto ai koe e hanga. Taria koe e ahu mai, ii, kia mataotaoo, ka hoki mai ai koe ki a hau.'†

"E hoa, kai te miharo ahau ki te parau o te Maori—he ika te kowhatu! He aha ra i ngawari ai te maro nei?

"Heoi ano. Ka mutu.

"Na Ha. te Rangikaheke."

Art. LXIX.—*Notes on Tombs of a Prehistoric Race of Colombia, South America.*

By R. I. Kingsley.

[*Read before the Nelson Philosophical Society, 18th June, 1894.*]

Plate LI.

Some considerable time since, Mr. T. B. Huffam, at my request, wrote to a near relative of his in Colombia, South America, requesting him to forward some seeds of certain plants I was anxious to obtain, and also any information or curios relative to the ancient inhabitants of that continent. Mr. R. B. White (the gentleman in question), writing from Valencia, Department of Cauca, Republic of Colombia, on the 13th May last, gives some interesting details of the country, and, in addition to enclosing seeds, gives a description of the

---

* This is the *third* time in this memorandum that this name is so spelled, "Arahua," but I think that Arahura is the proper term.

† An ancient ditty of great depth and meaning, often used by chiefs at their formal meetings at times of death or calamities; heard so sung by myself.

remains of the ancient inhabitants, illustrating his letters with numerous sketches, some of which I reproduce as diagrams. The information given by Mr. White forms the substance of this paper.

I believe I am correct in saying that, although a large amount of information has been collected with reference to the ancient races of North America, very little is known of those of the southern continent, especially of the northern portion of these. Mr. White says they were apparently quite distinct from the Incas of Peru, the most northern limit of the latter being at Pasto, which is three hundred miles to the southward. They appear to have been quite distinct from the ancient tribes of North America. The evidences are abundant of a large population, and to some extent highly civilized, there being statues and monuments with curious hieroglyphics inscribed thereon. These, however, were doubtless the work of a race antecedent to those the subject of this paper, whose methods of burial and specimens of ceramic art are described by Mr. White.

The unsettled state of the country, the unstable government of these South American republics, together with an unhealthy climate, tend to preclude scientific exploration at present, and what little information is from time to time obtained is chiefly gained from men who search for the graves of these ancient people in order to secure the gold ornaments buried with them.

Mr. White states that apparently there formerly existed many tribes, speaking different languages, probably cannibals, and indulging in constant tribal wars. He has not seen evidences of the art of writing, and very little trace of religion, although it is certain they believed in a future state. Their implements were of stone; there is no trace of iron; copper was sparingly used in ornament, silver also sparingly, but gold was common both as ornaments and in a kind of armour. Their pottery varied greatly from common, poorly made, with stamped patterns, to finely-shaped and handsomely-painted specimens. There are also evidences of cotton having been used in the manufacture of cloth. From the different methods of disposing of their dead, it is quite evident that there were distinct races of men in successive periods inhabiting the continent.

The men who make it their business to search for these ancient graves, for the sake of the gold ornaments buried therein, usually distinguish them under three headings, viz.: the "red Indian," the "hunting Indian," and the "purple Indian." Each of these had their own peculiar pottery, arms, and utensils, and the red and purple Indians differ also in the colour of the bones.

The red Indians were the tallest of the three; the skull was large and the leg-bones large and long; their implements roughly made, often merely chipped stones, mostly of phonolite or greenstone, flint being rarely used; their graves were mostly oblong holes, 15ft. to 20ft. deep, with niches at the sides to receive the bodies. Very few gold ornaments are found. The pottery is roughly made, neither glazed nor painted, and ornamented with lines and dots. The bones are usually stained red; hence their name.

The purple Indians, or Morado, were about 5ft. 8in. or 5ft. 10in. in height, the bones being bluish-grey in colour, although called purple. Their implements were of polished stone, well formed and polished. Buried with them are often large quantities of gold ornaments. From one grave, of which a sectional drawing is given, as much as 12lb. avoirdupois of gold was taken. The wife is usually found buried with the husband, and a slave or attendant (especially if there is a quantity of gold ornaments) is also found placed in a niche in the upper part of the shaft, as if on guard. Around the body are placed earthen vessels, doubtless to contain food, &c.; and at the head of each body are small effigies in clay. On the right of the man appear his arms and copper or gold ornaments. The passages leading to the vaults are often complicated; the shaft is from 25ft. to 60ft. deep, from the bottom of which the passage or tunnel, in a more or less tortuous direction, according to the rank of the dead, ends at length in a vaulted chamber. From the vault to a turn in the passage in a line with the shaft is usually a small hole pierced through the surrounding earth, evidently for ventilation. After the bodies were buried the entrance from the passage to the vault was barricaded with timber, and then the whole of the passages and shaft were filled in with earth, and so tightly rammed that the "grave-searchers" find it far easier work to sink a new shaft down on to the vault than to clean out the old one. They are enabled to do this, since by careful search the remains of a filled-in trench can be found, extending from the mouth of the shaft to a point vertical to the position of the vault. The trench has been so carefully filled in that both it and the shaft are extremely difficult to discover, and to be a successful grave-finder requires much practice and experience.

Among the favourite emblems on the pottery of the Morado race were owls (most probably parrots), frogs, and lizards. In the grave (the subject of the sketch, Plate LI.), in addition to the gold before mentioned, were found two clay effigies, the face of the one representing the woman being much broader and larger than that of the man. There was also a clay seal, of the impression of which a sketch is given. These seals are

excessively rare, and during a residence in the country of twenty-five years not more than half a dozen have been seen by Mr. White.

Some tribes cremated their dead, and placed the ashes, with leg-bones and skull, in a large jar about 2ft. high, and of elegant shape. Other tribes dried the bodies of their dead by the aid of the sun and smoke. Others again fenced their graves with bamboos in which slots were cut like organ-pipes, so that when the wind was blowing they gave out a howling noise, which, no doubt, was intended to frighten away evil spirits. Some Indians, Mr. White states, forced their stone axes into the branches of certain tough trees, and when the fibre and bark had securely grown around them they, by cutting off the branch, secured a natural handle to their axe. This style of burial of the dead does not appear to be similar to that of the North American races, but is more after the manner of the ancient Egyptians and old Etruscans and Scythians, whose remains are found in Egypt, Italy, and the Crimea.

The total absence of iron is remarkable, as we find it to have been used by the Egyptians fully four thousand years ago; and it was also known to the early inhabitants of Asia and Europe. In their reliance upon stone implements, and the apparent absence of the knowledge of the use of metal for that purpose, they greatly resemble the Maoris. I notice that Sir George Grey, in a recent speech at the Colonial Institute, stated his opinion that the Polynesians were of Mexican origin. I would suggest, Why not of South American? and in that light it is interesting for us in New Zealand to learn as much as possible of the probable habits and customs of the people formerly inhabiting that continent, in order to throw light upon the probable source whence the Maori race sprang, as I for one cannot with any satisfaction accept the reasons hitherto advanced (especially those of a philological nature) for the theory of an Asiatic source. Be this as it may, it is at least interesting to preserve any details illustrating the ethnology of extinct races of man.

Art. LXX.—*Maori Preserved Heads.*

By the Rev. Philip Walsh.

[*Read before the Auckland Institute, 1st October, 1894.*]

Most of the early writers on New Zealand mention the practice of preserving human heads, which appears to have been universal among the Maoris in their primitive state. None of the numerous accounts, however, are very complete, and most of them appear to be rather descriptions at second-hand than records of personal observation, the reason probably being not so much a lack of curiosity on the part of the writers as the fact that observers were necessarily few, and would, from prudential motives, naturally keep aloof from the scenes of which the heads formed the central point of interest; besides which in many cases, the actual business of preparation being strictly *tapu*, or sacred, an effectual bar would be placed against a too minute scrutiny.

In the present paper I do not pretend to give an exhaustive account of the subject so much as to propose the consideration of a question not only curious in itself but of great interest from an ethnological point of view, throwing light as it does on many peculiar aspects of aboriginal life and character, in the hope that it may be taken up by those who are better able to do it justice than myself.

In seeking for information I have largely availed myself of an unpublished journal* of the Rev. Samuel Marsden, the founder of the Church Mission in New Zealand, who, during several visits to this country in the early days of the century, enjoyed peculiar advantages for observing the customs of the natives in their primitive state. I also obtained a most minute and graphic description from Mr. W. King, of Waimate North, who, when a little boy, happened to be an eye-witness of the actual process of preservation of two heads, which, according to the general belief of the Bay of Islands natives, are those which are now in the Auckland Museum.

Though the custom from a civilized point of view was certainly a barbarous one, it was not practised from mere wanton brutality, or simply from a desire for personal aggrandisement on the part of the conqueror—like that of scalping, for instance, among the American Indians. No dishonour whatever was intended to the owner of the head: in fact, the exact opposite was the case. The distinction—for such it

* The original MS. is in the possession of Dr. Hocken, of Dunedin. The published journal consists of extracts from this work.

really was—was strictly reserved for persons of importance, and the heads of the chiefs of the tribe, and occasionally those of their wives and children, were preserved as well as those of the chiefs of the enemy who were slain in battle. Mr. Marsden states that "it is gratifying to the vanquished to know that the heads of their chiefs are preserved by the enemy"; and the same authority relates the case of a chief's wife who had the head of her sister preserved and placed in an "ark" near her hut, "in order that she might relieve her feelings by weeping over it." In fact, the curing of a head was an acknowledgment of the nobility of its original owner, and it is more than probable that many a young brave was supported under the pain of tattooing by the thought of the handsome and warlike appearance that it would give to his countenance whenever his head came to be preserved.

The principal object of the custom seems to have been to keep alive the memory of the dead; and the *mokomokai*, as they were called, supplied to a people ignorant of literature and the arts the place of statues and pictures and monumental records. In the case of the departed chief of a tribe they were a visible sign that in some mysterious way his presence still dwelt among his people, inciting them to emulate his virtues and to follow in his steps; while in that of the slaughtered warrior of the enemy they served to keep alive the memory of the injury received by the tribe in whose possession they remained, and were a constant challenge to revenge and retaliation.

As might be expected, the preserved heads were familiar objects about the old Maori pas. According to an interesting account lately published by the Rev. G. Smales,* those of the enemy were usually placed on the tops of the houses or on poles by the wayside, where they were exposed to the contemptuous taunts of the passers-by;† while those of relatives and friends were carefully kept in some secluded spot protected by the strictest *tapu*, whence they were brought forth and exposed to public view on great occasions, as, *e.g.*, the *hahunga*, a feast attending the ceremonial raising of a chief's bones, or the general gathering that took place on the eve of the departure of a war-expedition. The most important part which they played, however, was during the actual progress of the war, and in the negotiations respecting its continuance

* "Episodes in the Life of an Old Missionary," Auckland *Herald*, 1894.

† Mr. J. B. Lee, native teacher, of Waima, Hokianga, informs me, on the authority of Hone Mohi Tawhai, chief of that district, that the head of an obnoxious party would be dried, and, as an *ito*, would accompany its *rangatira* on fishing excursions, when it would be so fixed on the gunwale of the canoe as to nod freely if a fish took the baited hook, the line of which was attached to the ear.

or otherwise, when, as Polack* aptly observes, and as will presently be explained, they were not only the "trophies of battle," but the "oriflamme of either party," by whom they were "preserved similar to the tattered rags that *ornament* the cathedrals of polished nations."

In order to fully estimate the significance which attached to the various uses of these grim mementoes of departed grandeur it is necessary to understand something of the relations in which the chiefs stood towards their tribes. This may be roughly stated as very similar to that which existed in olden time between a Highland chieftain and his clan, and of which a shadow remains to the present day. Although there were often a number of minor chiefs scarcely inferior in rank, the position of the leading chief was distinct and supreme. He was the active intelligent representative head in whom was concentrated the strength and glory of the whole body of his people. He was their leader in war and their counsellor in time of peace. In all public matters his will was unquestioned, and on setting out on a fighting expedition his formal consecration by the tribal *tohunga* (priest) extended to the whole of his party. Any respect paid to the chief reflected honour upon the entire tribe; any insult must be wiped out if necessary by the blood of the whole body; and, conversely, an injury to the tribe was felt to be an injury to the chief, and must be noticed and avenged accordingly. Amongst his own people the person of the chief was enveloped in a peculiar sacredness (*tapu*), which extended to the most minute article of his belongings, but which was concentrated, so to speak, in his head, that part of the body being considered by the Maoris as the seat of honour and the home of all the virtues which the man possessed. To meddle with a chief's garments, weapons, or ornaments, or to eat the food prepared for him, was a grave offence, but to touch his head, although accidentally, or even to mention ti with disrespect, was a crime punishable with death.

In time of war the heads of the principal chiefs on either side formed the centre round which the whole business revolved. Whenever a chief fell within the lines of his own party, as Mr. Marsden was informed by Hongi and Te Morenga, the victors immediately demanded that the body be delivered to them, which was at once done if his people considered themselves unable to continue the fight. The head was then cut off, and all hostilities ceased, until, after an elaborate ceremony of "auguration," the *tohunga* declared whether the combat should be renewed. The head was kept for the chief on whose account the war had been undertaken; and as soon as it could be conveniently done it was preserved and sent round

* J. S. Polack, "New Zealand," 1838.

to all his friends and relations as a tangible evidence that justice had been satisfied and the war brought to an honourable conclusion.

As a matter of course, so long as the heads remained in the possession of a victorious chief no amicable relations could exist between the rival tribes. Should he, however, desire to make peace, he took them and exhibited them to the conquered party; and if these cried aloud at the sight of them this was taken as a signal that they were willing to put an end to the contest, and were prepared to accept the terms which might be offered; whereas if they kept silence it was understood that they were determined to hold their ground and risk the issue of another battle.* Sometimes it was the desire of neither party to renew hostilities—generally, no doubt, when both sides were weakened by excessive loss of fighting-men and tired of the continued struggle, or perhaps when they were threatened by a common enemy. In this case it was not unusual for the heads to be purchased by the friends of the vanquished and returned to the surviving relations, who held them in the highest veneration.

As in primitive times war was the common pastime of the people, and disputes on a greater or lesser scale were of constant occurrence, the number of these preserved heads must have been very large. Mr. Marsden relates that on the return from one of Hongi's expeditions against the East Coast natives no less than seventy were brought to Rangihou in a single canoe. And it was no uncommon occurrence for the early missionaries, during the fighting season, which occupied several months of the year, to see the palisading of the adjacent pa, or sometimes the fence of their own compounds, ornamented with a row of these gruesome trophies.

As from a collector's point of view a preserved head formed a very desirable item in an assortment of foreign curios, attempts to secure specimens were made from the very earliest period of our intercourse with the Maoris. For a long time, however, these attempts met with little success. Mr. Banks, the naturalist who accompanied Captain Cook's expedition, succeeded, after great difficulty, in purchasing one from the natives of Queen Charlotte Sound in 1770, but no inducement could prevail upon them to part with a second. And although Pomare, one of the principal chiefs of the Bay of Islands, and who was considered the most expert artist of his time in the preparation of heads, offered to show Mr. Marsden an example of his skill, and at the same time furnish him with some specimens if he would let him have some ammunition wherewith to shoot the people who had killed his son, his case seems to

* Marsden.

have been quite exceptional. As before remarked, it was only the heads of chiefs that were preserved; and, as their restoration to the tribes from whom they had been taken was the indispensable preliminary to the conclusion of a peace, they were far too precious to be traded away even for the coveted treasures of the pakehas.

But circumstances alter cases, and before very long an unexpected train of events brought an unlimited stock into the market. The terror of the great Hongi, who was the first New Zealand chief to obtain firearms, hung like a storm-cloud ready to burst over the tribes of the south, and every attempt must be made to meet him on equal terms. For a ton of dressed flax, laboriously scraped with a pipi-shell, a gun was purchased from the skippers of the Sydney schooners, or from the traders who early in the century began to establish themselves along the coast; but this process of armament was far too slow, and it was found that the preserved head offered just the ready means of barter that was required; and, as the purchasers were not particular so long as they obtained a good specimen, the honour of the *mokomokai* was no longer confined to the chiefs, but was extended to every man whose head would pass muster. Old grudges were raked up and small local wars undertaken to keep up the supply; and it is even stated that a good-looking slave was often elaborately tattooed so that as soon as it was required his head might be passed off as that of a distinguished *rangatira*.*

To such an extent did this trade extend that it attracted the notice of the Government of New South Wales, and an ordinance was published by which the possession of a preserved head was made a penal offence. And to this, less, perhaps, than to the fact that the Maoris gradually became possessed of the weapons by which they were able eventually to turn the tables upon their northern enemies, is to be ascribed the discontinuance of a practice that must have been most repulsive to their strongest instincts, and which would only have been adopted as a desperate measure for preserving their tribes from annihilation. In any case we find that the trade rapidly declined, and the custom itself has long since died out, so that for many years past the only means of obtaining a specimen has either been by exchange among the different museums or at the sale of some private collection of curios.

Mode of Preparation.

Of the mode of preparation of the *mokomokai* we have several accounts, none of which, as before observed, is complete, and most of them differing a good deal in detail. It is very probable, however, that the various artists purposely

* Compare Manings "Old New Zealand."

differed in their methods of treatment in their efforts to acquire an enviable distinction; and it is not unlikely that in the case of the more distinguished subjects extra care would be taken, and a more elaborate system employed. All authorities agree in stating that the brain, tongue, eyes, and as much as possible of the flesh were carefully extracted; the various cavities of the skull, nostrils, &c., stuffed with dressed flax; and the skin of the neck drawn together like the mouth of a purse, an aperture being left large enough to admit the hand. The lips were sometimes stitched together, and the eyes were invariably closed, as the Maoris feared they would be bewitched (*makutu*) if they looked into the empty sockets. This was done by a couple of hairs attached to the upper lids, and tied together under the chin.* The head was then subjected to a steaming process, which was continued until all remains of fat and the natural juices had exuded. Rutherford states that this was done by wrapping it in green leaves, and submitting it to the heat of the fire. Polack says it was steamed in a native oven similar to that used for food. Those seen by Mr. King were impaled on upright sticks set in open holes in the ground, which were kept supplied with hot stones from a fire close by, while the operator basted them with melted fat.† Each of these processes would equally serve the purpose required. The next stage was a thorough desiccation, effected by alternate exposure to the rays of the sun and the fumes of a wood fire, of which the pyroligneous acid helped to preserve the tissues and protect them from the ravages of insects. A finishing touch was given by anointing the head with oil, and combing back the hair into a knot on the top, which was ornamented with feathers, those of the albatros being usually preferred. The work was then complete. The form of the features was very fairly preserved; every line of the *moko* (tattooing) was distinct; and, although the likeness was sufficient to identify the departed warrior, the heads invariably bore a ghastly expression of life-in-death, which once seen can never be forgotten.

The Heads in the Auckland Museum.

The two specimens in the Auckland Museum originally formed part of the collection of Dr. Barnett Davis, of Lon-

* Mr. W. King's account.

† Hone Mohi Tawhai stated to Mr. J. B. Lee that he remembered when a boy seeing stone kettles among his people. These were hollowed out of soft stone, and the water was heated by means of red-hot stones, a constant succession of which was kept up by slaves. These kettles were called *kohue*, perhaps from a resemblance to a section of a dried *hue*, a gourd, which was similarly used for ordinary culinary purposes. The expression "*upoko kohue*" (boiled head) was the deepest insult known to the Maori language.

don, which was sold about 1880, and were acquired from the purchaser in exchange for a pair of Moriori crania from the Chatham Islands These heads are claimed by the Bay of Islands natives to be those of two of Kawiti's tribe named Moetarau and Koukou, who were killed in a fight which took place about sixty years ago near the site of the present railway-station of Opua. They were taken to Te Puna, where they were preserved by an old chief named Muru Paenga, and were afterwards presented to the party of Hokianga natives who had assisted in the fight, by whom they were eventually sold to the captain of a vessel for £20. These were the last heads preserved in the Bay of Islands.

Art. LXXI.—*Some Account of the Earliest Literature and Maps relating to New Zealand.*

By Dr. T. M. Hocken, F.L.S.

[*Read before the Otago Institute, 11th September, 1894.*]

What mystery surrounds the origin of the human race! Weary with the effort to penetrate it, men, both civilized and savage, seek rest in myth, and, after tracing back their ancestry through a chain with many broken links, exclaim that they are descended from the gods. Will the faithful labours of an increasing body of workers ever succeed in casting aside this veil and giving us fact for fable? Of equal mystery—yet of surpassing interest—are questions relative to the dispersion of the human race throughout the world, and to the history of that race before the time of that high civilization which, thanks to the labours of these workers, we know existed more than seven thousand years ago. Every year gradually unfolds to our astonished sight the spectacle of a mighty people possessed of all the magnificence and advancement of the present day, yet whose monuments have lain buried under a waste of sand and almost unknown for thousands of years. Where at that period was located that branch of mankind which to-day we call the Polynesian? Is it now the degraded remnant of a once-civilized people which occupied some lost Atlantis—some continent now buried beneath the Pacific waves? Perhaps, and probably, the tablets and papyri of Egyptian discovery will yield us abundant light on speculations of this sort. We may deem it impossible, because so inconceivable, that Portuguese, Spanish, Dutch, and English sailors were really the first to discover the Pacific Ocean,

and those numberless islets which lead to the gateways of the day. Rather let us believe that revelations await us in the buried records of the past, full of light on this portion of lost history, and that ours are but rediscoveries extending over the comparatively inconsiderable period of the last three hundred and fifty years. Be this as it may, it is certain that to this period our present inquiries must be limited, or, rather, to the still more limited period of two hundred and fifty years dating from Tasman's discovery of New Zealand in 1642. Doubtless before Tasman there were voyagers who had visited New Zealand, but of these we have no trace, or but the faintest. Soon after the great discovery of Columbus, adventurous Portuguese and Spanish poured into the Pacific seas. Their object was not to prosecute research, or even to gratify curiosity, but to amass wealth, and to annex distant lands to their own nationalities. Hence each maritime nation was jealous of its neighbour, and guarded its discoveries with every care from prying curiosity. Hence it followed that published accounts of voyages were few: the journals were consigned to close keeping, and were only utilized as occasion arose. If published, it was not unusual to find latitudes and longitudes omitted in a way that must have been provoking to the rival sailor. Similarly there are old maps in existence, issued a hundred years before Tasman's time, of whose history we know but little, and of which, certainly so far, there exists no written or printed record. Thus we are justified in thinking that there are buried in the old archives of Portugal and Spain journals which, if found, would give an earlier account of New Zealand than those we consider our earliest. A search for such should be made, and doubtless would well repay the discovery. The iron-bound chests of Portugal and Spain are the probable repositories of these treasures; or these may have been emptied into the papal and monkish libraries, upon whose shelves the contents are still resting, covered with the accumulated dust of ages. Sir James Hector, I understand, caused such inquiry to be instituted some years ago, but without result. A statement exists that, as far back as 1576, Juan Fernandez, a Spanish pilot, sailed W.S.W. from Chili for the space of a month, and that then he came upon a fertile and pleasant land, inhabited by light-complexioned people, who wore woven cloth, and who were exceedingly hospitable. From the course steered and the time occupied on the voyage it has been concluded that this fertile land was New Zealand. So well pleased was Juan Fernandez with his visit and reception that on his return to Chili he made extended preparations for a further visit to this "fertile land." His intention was cut short by death. Here is an instance in point where no

history remains. The little information we have is derived from a lengthy memorial presented thirty-five years later—that is, in 1610—to King Philip of Spain, by his dutiful subject Dr. Juan Luis Arias, who earnestly beseeches His Catholic Majesty to anticipate the English and Dutch by taking possession of the newly-discovered islands in the Pacific, and thus prevent the natives from becoming infected with the venomous heresy of those two nations. Possibly this slender and unsubstantial reference relates to New Zealand, and, if so, it is perhaps the first of which there is record. As it is evidently founded on a knowledge of Fernandez' voyage thirty-five years before, it is not unlikely that here is an example of unpublished manuscript for research to unearth. (*Vide* Dalrymple's Voyages, vol. i., p. 53; Burney's Voyages, vol. i., p. 300; and Hakluyt Society—Major's "Early Voyages," p. 1.)

One other reference to unverified utterance I think it well to repeat, as it seems to have value. On p. 65, vol. iii., of the Proceedings of our Institute, is a paragraph, vague enough, wherein it is stated that the Arabian geographers of the thirteenth and fourteenth centuries were acquainted with a large and mountainous country in the farthest southern ocean, uninhabited by man, and containing gigantic birds known as the "Seemoah." The paragraph does not state by whom, in this uninhabited land, these gigantic birds were called "Seemoah," but it proceeds to say that translations of these old Arabian geographers are to be found in the fine libraries of Paris and Vienna. I firmly believe that scientific, ardent, and well-endowed research applied to "Terra Australis Incognita," using that term in a different sense from that in which it was used during the last century, must result in discoveries of the first importance to ethnology. Unsatisfactory as are these dim allusions, they yet shadow forth an acquaintance with this country earlier than that which we are accustomed to estimate as the earliest.

Leaving them, however, I proceed to speak of our earliest authentic literature, and for which we are indebted to the Dutch. So early as the close of the sixteenth century this nation entered the lists as a competitor with the Spanish and Portuguese in the East India trade. Several trading companies were formed, but the rivalry between them became so keen and so destructive of fair profits that the Government of the United Dutch Provinces—of which Zealand was one—stepped in and cured matters by granting in 1602 a charter for the formation of the afterwards celebrated Dutch East India Company. The Island of Java was selected as the suitable centre of trade, and upon it, in 1610, was founded the City of Batavia, the capital. It was so named after the Batavi, who in the time of Cæsar were the ancient inhabitants of Holland.

From this capital sailed many an expedition in quest of discovery, and of new and fertile lands, which might extend the trade and fame of Vaderland. These were under the control and direction of the Governor-General, as he was entitled, and his Council. Amongst them was no one more eminent than Governor Antony van Diemen, and amongst his commanders none more skilful, or one who added more to the geographical knowledge of the time, than Abel Jansz Tasman. It was during such expeditions, ranging from 1606 onwards, that the western and southern coasts of Australia were discovered, and named, with true patriotic sentiment, New Holland. Tasman's memorable voyage, which is full of interest for us, extended over a period of ten months, and resulted in the discovery not only of New Zealand, but also of Tasmania, the Tonga or Friendly Isles, the Fijis, and others of less note. The expedition consisted of two vessels—the "Heemskerck" and the "Zeehaan." It was fitted out with much forethought, and, what was very unusual, if not unique, an artist formed one of the ship's company. The vessels sailed from Batavia on the 14th of August, 1642, for the Isle of France, or, as it is now called, Mauritius. Thence they proceeded south, discovering and naming Van Diemen's Land. Seven days after, on the 13th of December—not a bad passage for a sailing-vessel even in these days—they fell in with or descried the high land on the west coast of New Zealand. "Staten Land" Tasman first called it, believing it to be part of that great southern continent which his friend and countryman Schouten was supposed to have discovered twenty-five years before. However, on his return to Batavia, Tasman, finding that Schouten's continent was a small island, rechristened his own discovery "New Zealand," after one of the States of Holland. From the north cape of New Zealand he continued sailing north, adding to his discoveries. Keeping close to the north coast of New Guinea, he made Ceram and then Batavia, where he dropped anchor on the 15th of June, 1643, having thus performed a voyage which has conferred undying lustre on his name, and has marked him the foremost seaman of his century. As was the practice, his journal was handed in to the Governor Van Diemen and the Council, and its valuable contents were reserved for their special use and profit. It rested secure amongst the archives of the great corporation, safe from the longing eyes of trade rivals. But so important a contribution to maritime discovery was not allowed to remain entirely hidden, for thirty years after, in 1674, an abridged narrative of it appeared in Amsterdam by one Van Nierop. Short and unsatisfactory as this was, it was immediately translated into many European languages. But a much more valuable contribution was made in 1726 by Fran-

çois Valentyn in his publication entitled "The Old and New East Indies." Here is a much fuller, though still far from perfect, text of the original, and it is accompanied by copies of the thirty-eight plates drawn by Tasman's artist. Valentyn married a daughter of the secretary to the Council at Batavia, and it is readily seen how by a little piece of nepotism Valentyn gained surreptitious access to this and other valuable documents. His text remained long the standard. A translation of it appears in that splendid "Collection of Dutch Voyages in the South Pacific," published by the celebrated Alexander Dalrymple, Hydrographer to the Admiralty, of whom more anon. It is embellished with several of Tasman's quaint plates, one of which depicts the double canoe formerly used by the New-Zealanders. When Mr. (afterwards Sir Joseph) Banks returned from his great voyage round the world with Captain Cook he assumed that position of Mæcenas which his great wealth, education, and tastes enabled him to take, and, as we know, continued to the end of his life an ardent lover and supporter of literature and science. Whatever was curious or rare gravitated towards him, and thus he became possessed of what was considered—but incorrectly—Tasman's own long-hidden journal. This treasure was brought to England about 1773 or 1774, and was offered to Sir Joseph, who bought it without ado. We may be sure that no too curious questions were asked or answered on either side of the bargain. The services of the Rev. Charles Woide, chaplain of the King's Dutch Chapel at St. James's Palace, were secured to translate it, and this translation, with charts and illustrations, appears in Burney's Voyages, vol. iii., 1813. This supplies us to the present time with the most complete account we have in English of Tasman's discoveries. Mr. Woide expressed the belief that this was not the original, but an imperfect copy. This opinion I am quite able to confirm, having collated Dalrymple and Burney with an authentic copy of the original Dutch journal in my possession, and which is here exhibited. It is printed in its entirety by the old-established firm of Van Keulen at Amsterdam, celebrated as cartographers and nautical publishers. The book is but little known apparently beyond Holland, perhaps because interest in the subject is limited, and also because Dutch literature, unlike French and German, is almost confined to its own land. To Jacob Swart is due the honour of giving to the world Tasman's perfect journal. This gentleman was, or is, if he is still alive, a Knight of the Oaken Crown of Holland, a member of various learned societies, a lecturer in the Naval School, and editor of the Zeemans-Almanak, the equivalent probably of our Nautical Magazine. From the introduc-

tion it would seem that the letter-books, journals, foliants, charts, &c., of the old Dutch Company had been transferred from the iron chests of Batavia to the more congenial shelves of Van Keulen's establishment at Amsterdam, and that many had been submitted to the critical study of the editor. Amongst these was Tasman's journal, which Swart had already originally contributed in parts to a nautical magazine, but which he here presents in a collected form, and well annotated. Appended is a copy of the original chart, showing Tasman's track on both his voyages; for, on his return to Batavia in 1643, he was again despatched in 1644 to examine the north coast of New Holland, and to explore what is known to-day as Torres Straits, which separate Australia from New Guinea, but which then were not known to exist. Tasman failed to sail through them—a feat which it was reserved for Cook to perform. Even at the present day Dutch is not a mellifluous tongue; but what it was two hundred and fifty years ago I leave those to discover who contend with the crabbed and hard-favoured words of Tasman's journal. It has not yet been put in English dress; but, with the assistance of a valued coadjutor, I can promise that the Institute shall soon have presented to it the first full English translation of Tasman's discoveries of Tasmania and New Zealand. In taking leave of this eminent seaman, I would refer to the quaint, pious way in which he begins and ends his journal, which is something after the manner of a child saying grace before and after meat: "May God Almighty be pleased to give His blessing on this voyage. Amen." "May God be praised and thanked for this prosperous voyage. Amen." Tasman was born in Holland in 1602, and died at Batavia in 1659 at the comparatively early age of fifty-seven years.

And now for the long space of one hundred and thirty years nothing more was known of New Zealand than that which Tasman's discovery had vouchsafed. Little by little something was added to the chart of the South Seas, but there in a remote corner remained unaltered and with sphinxlike impenetrability the curious piece of coast-line which Tasman's hand had traced. Speculation concerning it was always keen, and it was pretty generally agreed that it formed part of that vast Terra Incognita of the Southern Hemisphere whose existence was considered necessary to balance the great globe. To Cook, as we know, fell the honour of solving the mystery, and how thoroughly he solved it we also know. Our task, however, is not to describe his labours, but to review the manner in which they have been recorded, as well as those of his companions, on the occasion of the three celebrated voyages. That famous barque the "Endeavour," of 350 tons, returned from her three years' voyage

in June, 1771, laden with more valuable spoil than ever ship before; collections and curiosities of all kinds, wonderful stories from the uttermost parts of the earth, large and important additions to the scanty map of the Southern Hemisphere, faithful drawings of new scenes, and the valuable journals of those who had undertaken this great voyage. All Europe rang with the event, and eagerly awaited the details. The Admiralty determined that these should be given to the world in a befitting way, and they therefore intrusted the editing and publication of the journals and papers to a well-known literary man—Dr. John Hawkesworth, who from a very humble origin had raised himself to a position of eminence in the literary world. His degree of LL.D. was conferred by the Archbishop of Canterbury, who, amongst other functions, exercises to this day the curious one of granting degrees without examination. Hawkesworth was a miscellaneous writer, had been associated in literary ventures with Johnson and others, had written poetry, essays, romances, and plays, all of which had been well received. It was doubtless through his connection with Garrick, in the matter of the drama, that the influence of this great actor was exercised in procuring for him in 1771 his post of editor under the Lords of the Admiralty. His task was completed in what we should now consider the protracted time of nearly two years, and then appeared, in 1773, in three volumes quarto, his "Account of the Voyages undertaken by the Order of His present Majesty for making Discoveries in the Southern Hemisphere." The first volume is devoted to the voyages of Captains Byron, Wallis, and Carteret, who had conducted their explorations during the nine years previous to Cook; the second and third volumes contain the account of Captain Cook's first voyage; and the whole three form part of the eight which, together with the separate atlas of plates, form the *editio princeps* of "Cook's Three Voyages." Now, how did Dr. Hawkesworth execute his really difficult task? The papers and periodicals of the time reply that it was executed very badly indeed. He was accused of justifying the murder of savages, of introducing obscenities, of failing to recognize the protecting hand of Providence throughout the dangers of a remarkable voyage, of interpolating his own heavy remarks upon its varied incidents, and generally of presenting to his readers an exceedingly ponderous and unreadable version of what should have shone and sparkled with the genius of Cook and the accomplished descriptions of Banks. So beset was the unfortunate editor by these pungent criticisms that he died of chagrin and low fever two years later, at the premature age of fifty-eight. He did not deserve this fate so far as I may judge, and I have carefully read over his narration more than once. The separate journals of Cook,

and Banks, and probably of Solander, were intrusted to him to weld or weave together in the most skilful and agreeable manner he could. This must have been a difficult task. Cook, though a genius, had not, to use his own words, "the advantage of much school education," nor "the plausibility of a professed bookmaker." And this is quite apparent on perusing his original journal, which, curiously enough, first saw the light but last year, and to which I shall again presently refer. Interesting as it undoubtedly is, much of it relates to those purely nautical matters of which every captain takes daily note in his log. Banks's journal has not yet been published, though there are perhaps three or four manuscript copies extant, one of which I have had the advantage of seeing. He wrote this journal when a young man of twenty-five. Later on in life, and though President of the Royal Society and a Mæcenas, he showed no special literary ability, and it is therefore fair to conclude that his journal suffered no injury from Dr. Hawkesworth's treatment, and, at any rate, Banks himself uttered no complaint. Altogether, I am of opinion that our judgment may reverse that of one hundred and twenty years ago, and that we may consider Hawkesworth's account as a complete and able one. To this day, however, some critics repeat the old charges. It must not be forgotten, too, that both Cook and Hawkesworth had bitter enemies, who hurled some of the shafts of this envenomed criticism. That able man, Alexander Dalrymple, Hydrographer to the Admiralty, was one. He held the opinions strongly that when the expedition for South Sea discovery was fitted out its command should be conferred upon himself, as one specially fitted for it, and also that, without doubt, there existed in the Southern Hemisphere an undiscovered continent. Hence, when Cook was appointed to the command, and especially when the keel of the "Endeavour" passed over the site of this supposed continent, these opinions were magnified into grievances, which Dalrymple plainly sets forth in a rare letter or pamphlet addressed to Dr. Hawkesworth. In this, he accuses him of having made groundless and illiberal imputations in his account of the voyages, which he then proceeds to slaughter in a very merciless manner. He further reiterates his belief in the continent, although Cook had sailed more than 20° south of the coast-line laid down in a chart constructed by himself prior to the sailing of the expedition.

Every precaution was taken that no account of the voyage, however brief, should appear before that under the auspices of the Admiralty. The public curiosity was keen, and its edge was not to be dulled. Naval officers are to this day forbidden to publish their journals without permission of the

Admiralty, to whom, indeed, they are handed over. Despite this care, some leakage occurred, and two or three short and anonymous publications made their appearance. One of them, a small quarto of 130 pages, with a three-page vocabulary of Otaheite, has been attributed—I am sure, incorrectly—to the joint authorship of Banks and Solander. But to one large and important work of this surreptitious sort I must make special reference. It is the Journal of Sydney Parkinson, who was engaged by Mr. Banks as his draughtsman. Quite a melancholy and romantic story attaches to this interesting book, which is partially told by Mr. Colenso in vol. x. of our Transactions. As this gentleman was evidently unaware of the whole story, I shall not hesitate to record it more fully, and so to supplement it as to do Sir Joseph Banks justice, and free his name from that grave reproach under which it rests in the pages of Mr. Colenso's article, "Manibus Parkinsonibus sacrum." Young Parkinson was a very intelligent, gentle youth, the son of a Quaker in Edinburgh. His skill in the use of the pencil, and the fidelity with which he drew plants and objects of natural history generally, led to an introduction to Mr. Banks, who was then about to sail with Captain Cook in the "Endeavour." Mr. Banks offered him the post of draughtsman, at a salary of £80 a year and rations. This offer, so agreeable to his curiosity and love of nature, the young man joyfully accepted. He gained the affection of all on board, and performed his artistic duties in the most competent way. His botanical drawings, which now lie in the Banksian Collection at the British Museum, are of great beauty and accuracy, and attest his merit. After nearly three long years of absence the "Endeavour" turned her head towards home. Near Batavia the dread scourge of dysentery and fever struck the vessel. Amongst the victims was poor young Parkinson, who died in January, 1771. Barely was the anchor dropped in English waters before his brother Stanfield demanded the papers, drawings, and curiosities of his deceased relative. Mr. Banks, who had possession, contended that all these belonged to him, as Sydney Parkinson's employer. He was, however, willing and desirous to make the most liberal concessions, both pecuniarily and in the way of permitting a selection from the curiosities for friends. Here the negotiations became of a very disagreeable and prolonged character, notwithstanding the judicious mediation of the celebrated Dr. John Fothergill, who was not only a friend of Mr. Banks, but was also, like Parkinson, a Quaker, and presumably therefore disposed to act with justice and sentiment to both parties. It soon became evident that Parkinson was the tool of designing persons, who advised him to be first in the field with what material of his brother's he could collect and

publish. Under a solemn promise that he would merely peruse and make no other use of it, Mr. Banks lent him his brother's journal, which, naturally enough, he had expressed a strong desire to read. This secured, Parkinson lost no time in preparing it and some sketches for the press, and the work thus compiled was ready for issue much in advance of Dr. Hawkesworth's. An injunction was at once applied for and obtained in the High Court of Chancery, suspending its publication; but meanwhile seventy copies had been issued. These are now extremely rare. After argument, the injunction was annulled; but this involved a delay which was fatal to the sale and success of the book, supplanted as it speedily was by Hawkesworth's fuller and much more interesting account. The introduction to Parkinson's Journal recites the whole dispute, of course from Parkinson's point of view, and the reader would not hesitate to conclude that poor Parkinson had been shamefully oppressed by the wealthy and powerful Mr. Banks and Dr. Fothergill—a conclusion naturally enough expressed by Mr. Colenso in his article. But eleven years later a different complexion was placed on the matter; for in 1784 appeared a fresh edition, or, rather, a reissue, of the work, in which the calumnious statements were refuted by Dr. Fothergill, who further showed that Parkinson had been guilty of treachery and ingratitude. To settle all demands, and to prevent the possibility of any dispute, it was proved that Sir Joseph Banks had given Parkinson the liberal sum of £500, had permitted him to select from the curiosities, and to peruse his brother's journals—a confidence which, as we have seen, was grossly abused. Parkinson, who, it would seem, had always been in necessitous circumstances, became insane, and after some years' detention died in a lunatic asylum, leaving his family unprovided for. Dr. Fothergill, as a co-religionist, and as one brought in this curious way into close contact with him, now acted generously to the distressed family. He also bought from the executors the unsold portion of the Journal, numbering nearly four hundred copies. These, with a valuable compendium of previous South-Sea voyages and other additions, form the issue of 1784. The book is of much value, and the plates, thirteen of which relate to New Zealand, are of great beauty: in a few copies they are coloured.

Returning from this digression: Hawkesworth's edition met with a large and immediate sale, and was at once translated into French and German. To Banks's liberality and public spirit its excellence is largely due. Not only is the history of the voyage drawn largely from his journal, but the illustrations, with the exception of the charts, are supplied from the admirable drawings of the two artists, Parkinson and Buchan, whom he engaged to accompany him round the

world. This voyage owed much to Sir Joseph Banks's princely liberality. He expended upon it no less a sum than £10,000. To Dr. Solander he paid £400 per annum during the voyage.

I have said that only last year did Cook's original journal see the light of day through the press. To Captain Wharton, Hydrographer to the Admiralty, are we indebted for this. It appears that Cook kept his journal in triplicate, in obedience to a requirement of the service. These copies were written by Orton, his clerk, but they have many additions and interlineations in Cook's own handwriting. One of them was forwarded to the Admiralty from Batavia, and is, of course, complete only to the date of arrival at that port. This copy had been evidently appropriated by Sir Philip Stephens, Secretary to the Admiralty; from him it passed to his descendants, was sold in 1868 to Mr. Cosens, and again sold in 1890 to Mr. John Corner. The second copy is now in the possession of the Admiralty, though for some years it was missing; and the third copy is the property of the Queen. It is from Mr. Corner's copy, collated with that of the Admiralty, that Captain Wharton's volume has been edited, and it contains all the odd spelling, shrewd remarks, and quaint composition of the original; much-abused Dr. Hawkesworth is evidently and entirely absent. On this, his first voyage, Cook spent nearly six months in and around New Zealand, from the 6th October, 1769, to the 31st March, 1770. His chart or map of New Zealand, which appears in Hawkesworth's account, has won the praise of all for its accuracy. Curiously, he placed the North Island 30min. and the South Island 40min. too far east. The site of Wellington is placed on the Wairarapa plains, that of Dunedin forty miles out to sea. This error was corrected on the second voyage.

The second voyage was undertaken on a much more extensive scale than the first, and the literature connected with it is correspondingly extensive. Its great object was to set at rest the still fervent question of the Great Southern Continent, which still occupied men's minds, and especially that of Mr. Dalrymple, who, as we have seen, put trifling value on Cook's discoveries. King George, moreover, was far from satisfied, and considered that the great expectations he had formed had not been realized by the recent discoveries. On this occasion two vessels were attached to the service—the "Resolution" and the "Adventure," the latter being under the command of Captain Tobias Furneaux. To Captain Cook's regret his favourite old "Endeavour" had been sent to the Falkland Isles. The patriotic Sir Joseph Banks again made every preparation to accompany the expedition. As

previously, he, at his own expense, made extensive preparations to insure the success of the voyage from a scientific point of view. He engaged quite a retinue of assistants, and sent on board an ample supply of stores and of scientific instruments, which were placed in an upper works or top-hamper on board the "Resolution," which had been erected under his own supervision. Dr. Solander was again to form one of the party, and there were also one or two other scientific men. At the last moment, when all were ready to start, the pilot found fault with Sir Joseph Banks's additions, which he considered absolutely unsafe for such a voyage, and likely to cause disaster. Banks, in high dudgeon, at once ordered his goods ashore, bade adieu to all, and started on his well-known tour to Iceland. Mr. Banks's scientific friends followed their chief. In this dilemma the Royal Society recommended Dr. John Reinhold Forster as competent to undertake the post of naturalist and to make scientific observations. Dr. Forster was accompanied by his son George, a youth of eighteen.

The expedition sailed in July, 1772, and after an absence of three years returned in July, 1775. It was welcomed, as before, with every demonstration of curiosity and pride, and every effort was made to have the account of the voyage published with less delay than before. Captain Cook is credited with having on this occasion acted as his own editor; but, as a matter of fact, the account of the voyage was edited by the Rev. Dr. John Douglas, who was afterwards successively Bishop of Carlisle and of Salisbury. It will be of some interest here to say that this learned critic and divine was the grandfather of Mr. J. A. Douglas, formerly a runholder in this province, of the firm of Comber and Douglas, of the Upper Waitaki. The work was issued in two quarto volumes, and appeared a few days after Cook's departure on his third and last voyage in 1776. The illustrations were chiefly done by Mr. William Hodges, who was engaged by the Admiralty to take portraits and landscape views. New Zealand was visited twice on this voyage, and a stay made there of three months altogether.

As a highly disagreeable incident occurred in the Parkinson episode, so now one somewhat similar took place in an unexpected quarter. Throughout the voyage Dr. Forster cherished the idea—and probably with good grounds—that on arrival home the honour of writing its history would be intrusted to him; and for this task he was undoubtedly well qualified. He was a learned scientific man, an extensive linguist, a good observer, and was in high favour with the Royal Society. Add to this that, unlike the ponderous Hawkesworth, whose acquaintance with salt water

was confined to that of the Thames, he formed one, and a *magna pars*, among the voyagers, and his qualifications seem complete. Unfortunately he was of overbearing temper, quarrelsome, and passionate, and during the voyage he succeeded in securing the hearty dislike of his comrades. By the time New Zealand was reached he had fallen out with all. During his disputes he had a childish trick of saying, "I shall tell the King; I shall tell the King." The very sailors caught up the words, and jeeringly used them in their own quarrels. On two occasions he behaved so severely, if not cruelly, to the natives that Captain Cook placed him under arrest. It is, however, gratifying to observe that his references to the great commander are invariably couched in terms of praise and admiration. On arrival home, to his chagrin he learnt that, whilst the Admiralty expected him to publish his own scientific observations, for which purpose the artists' drawings were placed at his disposal, he was forbidden to contribute to the history of the voyage. This the Admiralty desired that Captain Cook should undertake. An agreement was drawn up precisely specifying the special part allotted to each, and Forster was informed that any infringement would entail the loss of half the profit accruing from the sale of the books. Forster, obliged to acquiesce in these arrangements, published his "Observations . . . on the Physical Geography, Natural History, and Ethic Philosophy" of the voyage, in a thick quarto. But father and son conjointly were not thus to be outwitted. If the father was stringently bound the son was not, and so there speedily appeared—anticipating, indeed, by three or four months Cook's publication—"A Voyage round the World in His Britannic Majesty's Sloop the 'Resolution.'" This was in two large volumes quarto, with the son's name, George Forster, on the title-page, the said son being then but just twenty-two years of age: curiously enough he was at this tender age a F.R.S., as the initials appended to his name attest. The Admiralty were naturally incensed with such sharp practice, and at once withdrew all further countenance and patronage. The result was that the twain soon found it necessary to depart for Germany, their native land, whence from time to time they issued other contributions which have much enriched our knowledge of this voyage. In his preface the son naively says, "I was bound by no agreement whatever, and that to which my father had signed did not make him answerable for my actions, nor in the most distant manner preclude him from giving me assistance. Therefore in every important circumstance I had leave to consult his journals, and have been enabled to draw up my narrative with the most scrupulous attention to historical truth." This is queer morality: *qui*

facit per alium facit per se. And so it was with Stanfield Parkinson. Yet posterity, whilst condemning the method, must congratulate itself on the possession of such valuable results. If Solander, Banks, and Cook had published each his own separate account there would have been no plagiarism and we should have been all the richer. To the "Characteres Generum Plantarum," published in 1776 and dedicated to the King, we are indebted for the first contributions to our New Zealand and South Sea Island botany; the plates are exceedingly primitive, especially those in the German edition published three years later when father and son had shaken the English dust from their feet. Their name remains with us in *Forstera*, a genus of New Zealand alpine plants. In 1786 appeared a "Dissertatio inauguralis Botanico-medica de Plantis esculentis Insularum Oceani Australis." This is of eighty pages octavo, and is of considerable interest. It would be tiresome to particularize many other products of their pen, which were chiefly pamphlets of a disputatious kind and an outcome of the treatment they had received.

I do not here more than refer to the astronomical treatises of Charles Green, William Wales, and William Baily of the two voyages; nor to the work of Dr. Andrew Sparrman, who joined the expedition at the Cape of Good Hope as an assistant to Dr. Forster.

Nor on this occasion did Cook's enemies omit to launch their shafts of ridicule. A volume appeared with this odd title: "The Travels of Hildebrand Bowman, Esquire, into Carnovirria, Taupiniera, Olfactaria, and Auditante, in New-Zealand; in the Island of Bonhommica, and in the powerful Kingdom of Luxovolupto on the Great Southern Continent. Written by himself; who went ashore in the 'Adventure's' large Cutter, at Queen Charlotte's Sound, New Zealand, the fatal 17th of December, 1773, and escaped being cut off and devoured, with the rest of the Boat's crew, by happening to be a-shooting in the woods; where he was afterwards unfortunately left behind by the 'Adventure.'" This very rare book is written somewhat after the manner of "Gulliver's Travels," and is full of concealed raillery, apparently directed against Cook, Banks, and Solander, whose adventures are travestied. In one of the illustrations two men are represented walking on the pavement, whilst a third, apparently Cook, is floating in the air in the arms of a flying female, whose hair is dressed in extraordinary fashion. It is difficult to suggest the writer of this skit: perhaps it was Dalrymple, who to his dying day never forgot to sneer at Cook,—or perhaps the celebrated Dr. Horsley, who had no more affection for Banks.

The third voyage—from which, alas! Cook was not destined to return—had for its object the discovery of a north-

west passage through which vessels might sail to the East by a short route, instead of by the long journey round the Cape. As all previous expeditions with this mission had failed, it was now determined to make the attempt from another direction, and to seek an entrance from the Pacific instead of from the Atlantic Ocean. As we know, this discovery was achieved by Sir John Franklin in 1847. Had Cook been spared to complete his voyage it is quite probable that his experience, skill, and determination would have conquered the difficult problem set before him. As with the previous two, so this voyage proved rich in contributions to its history. It extended over four years—from July, 1776, to October, 1780. The vessels were the old "Resolution" and the "Discovery," the command of the latter devolving on Captain Clerke, and, after his death, on Captain James King. The month of February, 1777, was spent in New Zealand, at the old favourite spot in Queen Charlotte Sound. The account of this voyage appeared in 1784 in three large quarto volumes; the first and second nominally by Cook, the third by King. Again the services of Dr. John Douglas as editor were put in requisition; but from the introductory remarks it would seem as though Cook had formed the strong resolve of editing himself his journal and of trusting to no deputy. But death forbade this. The plates and charts were, as previously, of the best character, and executed by eminent engravers from the drawings of James Webber, the artist of the expedition. The plates are of large size, and were consequently issued separately in elephant folio. Some copies of the letter-press have, however, the plates infolded. A few copies of the folio plates have an additional engraving at the end by the celebrated Bartolozzi, representing the death of Cook. Such copies are very rare and accordingly valuable. In 1808 an additional folio of coloured illustrations by Webber was published. One of the views represents Ship Cove, in Queen Charlotte Sound, where Cook was wont to lie. The representation is most faithful, and I immediately recognized the spot when visiting it five years ago. The great earthquake of 1846, which did such damage at Wellington and which raised the eastern beaches, had here the effect of depressing the land some feet below the water. Hence the beach whereon Cook erected his huts, and which is depicted in Webber's illustration, no longer exists.

These nine volumes, then, form the complete and original edition of Cook's voyages; though, as has been explained already, the first relates to the discoveries of Cook's immediate predecessors. It is needless to speak of the numberless editions which have since appeared and with some of which we are all acquainted. I may, however, add

that much extra matter, and some of it of value, is to be found in those compilations of the voyages which appeared soon after the publication of the original, in the numerous collections of voyages issued towards the close of the last and the beginning of this century; such, for instance, as Portlock's and Anderson's. The compilers interviewed many of Cook's companions, and thus procured some extra details. The British Museum contains a large number of manuscripts, drawings, charts, and other unpublished collections relating to Cook's voyages, which are of great interest and should be brought into the light of day. I have a list of perhaps thirty of these. Here, again, is an opportunity of conferring a great service open to any one possessed of wealth and patriotic spirit. The Museum authorities would gladly grant permission to any person desirous of placing these in an available form.

Fifteen years ago—in 1879—occurred the centenary of Cook's death, and this was commemorated at Paris in a very distinguished way by the Société de Géographie. The members of this great society held a séance, at which many eminent persons assisted. Orations were delivered, eloquently referring to Cook and his labours, to Dalrymple, and to Hawkesworth, and reviewing our rapidly-increasing knowledge of Oceania. There was also exhibited an extensive collection of articles which had belonged to Cook or were personal to him, his manuscripts and those of his companions, of old drawings, and of curiosities from the South Seas, lent by the British Admiralty, Lady Brassey, and many other persons, all proud to aid so great a celebration. A full account of these proceedings was issued by the Society in a bulletin, together with a very excellent cartography and bibliography, the whole forming a very valuable, but little known, contribution to the literature of the subject. In reading this, one feels not only pleasure, but also a warm sense of gratitude towards the French nation in thus doing honour to our great countryman. But, indeed, Cook, like Shakespeare, belongs to all nations. To the French we are also indebted for early literature relating to New Zealand. At the very moment, in 1769, when Cook was sailing down the west coast of the North Island in the "Endeavour," Captain De Surville was on the east coast in the "St. Jean Baptiste," each unaware of the other's vicinity, and separated by but a few miles. The history of De Surville's visit to New Zealand is very interesting. His vessel was chartered to trade to various islands in the Indian seas, and with this view was being fitted out in the French settlement of Pondicherry. At this moment astounding news was suddenly circulated that the English had discovered a wonderful island somewhere in the South Seas, which not only abounded in gold and other riches, but also contained a

curious colony of Jews. The destination of the vessel was at once changed to a search for this remarkable spot. It was on this quest that De Surville fell in with the coast of New Zealand at Mongonui, or Doubtless Bay, as Cook had named it three days before De Surville's arrival. The Frenchman called it Lauriston Bay, probably after M. Laws, who was the Governor of Pondicherry and one of the charterers of his vessel. Here he stayed for three weeks, being received very hospitably by the natives—a hospitality which he requited in a discreditable manner. During a terrible storm, of which, indeed, Cook also speaks, he lost one of his boats. Suspecting the natives of having stolen it, he set fire to their village, otherwise maltreated them, and kidnapped their principal chief Naginoui, whom he took with him to sea, and who shortly afterwards died heart-broken. For the only account we possess of this voyage we are indebted to the Abbé Alexis Rochon, himself an extensive traveller. The abbé happened to be at Pondicherry at the time of the "St. Jean Baptiste's" return, and thus got access to De Surville's journal. From it he made those extracts which appear as an appendix to his "Nouveau Voyage à la Mer du Sud," published at Paris in 1783. These extracts give us the sole knowledge we possess of the first visit of the French to New Zealand. From some remarks the abbé makes it is apparent that the original journal contains further information regarding the natives and the productions of the country, which he did not think it worth while to detail. Now, where is this lost journal? This "Nouveau Voyage" is an extremely rare and valuable book, copies fetching as much as £3 or £4. It also contains the sad and eventful story of the second visit paid to these shores by the French in 1772 in the ships "Mascarin" and "Marquis de Castries," under the command of Marion du Fresne and Duclesmeur. On this occasion the vessels were anchored at the Bay of Islands, known on the old French maps as the Bay of Treachery, for more than a month. Apparently the utmost friendship existed between the natives and the French, and then, without a moment's warning or the least suspicion, that terrible catastrophe took place when Marion and nearly thirty of his officers and men were massacred and eaten. I think we are all pretty well acquainted with the story. The command devolved on Crozet, Marion's lieutenant, and after his arrival home the journals were edited and published by the Abbé Rochon. Thus they are known as "Crozet's Voyage." They were excellently translated into English three years ago by Mr. Ling Roth, the Librarian of the Imperial Institute; the translation, however, does not reproduce the old plates and charts of the original edition, nor the abbé's preface, nor the appendix relative to De Surville—omissions which I pointed

out in a review appearing in the *Otago Daily Times* of November, 1891. The abbé considers that the massacre was a just retribution—*utu*—for De Surville's brutal cruelty three years before. Long afterwards the "Wiwis" were known amongst the natives as "the bloody tribe of Marion."

With the years 1783 and 1784 terminates the history of the earliest New Zealand literature. It reopens again in 1807, with "An Account of the Bay of Islands," written by Mr. Savage, who was surgeon of one of the early convict vessels to Botany Bay. After discharging its human cargo of criminals on the shores of New South Wales the ship was sent down in 1805 to New Zealand to collect a cargo of spars for the British navy. This writer has, then, the honour of being the author next in order after Cook, with an interval of nearly five-and-twenty years between them. From this time onwards, and to the present day, the publications anent New Zealand have increased and multiplied exceedingly. At times they have poured forth from the press in a perfect torrent, and it may be asserted that for its age and size no other country has had more written concerning it. But an account of these does not come within the scope of this paper.

My subject would not be complete without saying a few words relative to an old map, dated 1542, a century before Tasman's discovery of New Zealand. It was executed by one Jean Rotz, was dedicated to Henry the Eighth, is in the British Museum, and is over 7ft. in length. This interesting and ancient map is one of four, also in the British Museum, which were photo-lithographed ten years ago at the joint expense of the Governments of New South Wales, Victoria, and South Australia. In this the Governments of these colonies have acted with a noble public spirit, and have done a very great service in extending a knowledge of such old documents, which are certainly the oldest charts of Australia known to exist. The originals were made the subject of much careful study by Malte-Brun, more than sixty years ago, in his "Histoire de Géographie," and still more fully in 1859 by Mr. Major, of the British Museum, in a long and learned contribution to the Hakluyt Society. The whole subject is one of great intricacy, and requires much patience and further research before it can be fully elucidated. For some time I have been collecting information upon it from many sources, which I shall have the pleasure of laying before the Institute at another time. Meanwhile, I exhibit a facsimile section of that portion of Jean Rotz's map which contains all that was known of Australia before 1542. It may fairly be presumed that the large islands to the east are those of New Zealand. To the small island is affixed the name of "Y^{a} de Saill," to the larger "Yslas de magna."

And now a door for the widest speculation opens. It may be accepted as proved, by those who have made these early maps their study, that accuracy of latitude and longitude, or much approach thereto, is not to be found in them, and that the positions of many of the countries and of their coast-lines are constantly misplaced or distorted. All this is what we might expect in the infancy of cartography. Witness, in the map before us, the close proximity of Java to the northern coast of Australia—Iava la Grande, or the Londe of Iava, as it is called—where but the width of a large river or narrow strait divides the two countries. Again, this huge eastern projection is supposed, with considerable reason, to represent Tasmania. Here it has been tacked on to Australia in a manner most regardless of every cardinal point. If this be allowed, we must view "Bay Neufve" as Bass Strait, and the "C. de Fremose" as the south-east point of this Island. If this be admitted, I would hazard the conjecture that the "Yslas de magna" is our South or Middle, and the "Y^{a} de Saill" the southern portion of the North Island, with Cook Strait between. Dusky Bay would be represented by this conspicuous opening. Some may think that with further cartographical perversity Jean Rotz has placed the islands in reversed position; and, if so, we may assume that Stewart Island and the Middle Island are represented, with Foveaux Strait between them, and that the North Island is not shown at all. I incline to the first conjecture, and shall be glad on a future occasion to give reasons for this belief. Meanwhile, this strange map shadows forth the strong probability that New Zealand was known to Europeans, and most likely the Portuguese, at least three hundred and fifty years ago. In concluding with this portion of my subject, it is needless to point out the remarkable interest which surrounds it; and if I have succeeded in gaining for it your sympathy, and, what is more important, the determination to make research for yourselves, I am content.

I.—ZOOLOGY.

[CONTINUED.]

Art. LXXII.—*On a New Species of Ant from New Zealand.*

By Prof. C. Emery, University of Bologna (Italy).
Communicated by W. W. Smith.

[*Read before the Wellington Philosophical Society, 20th February, 1895.*]

The Formicidæ of New Zealand are of high zoological interest. We may regard the actual fauna as a relic from an old Australian fauna that remained there unmixed and safe from Indian immigrations which took place on the Australian continent, but was badly disseminated by partial submersions and by the rigorous climate of the glacial epoch. Evidence of the great influence of the Ice Age may be assumed from the fact that the most characteristic Formicidæ of New Zealand (and, as Mr. W. W. Smith informs me, the termites) are found only on the North Island; very few species of ants are found living on the South Island, and none peculiar to it. I therefore think that the glacial climate destroyed all the ants and termites on the South Island. Later a few of the most diffusible species (*Monomorium, Huberia, Lasius*) wandered across the sea towards the south.

In 1892 my friend Professor Forel published* a list of the New Zealand Formicidæ, and described some new species. Since that year a few more have been discovered. Professor Forel has lately described *Monomorium integrum;* while two other species, a *Ponera* and a *Huberia,* will shortly be desribed by him.

The only known ant from New Zealand not seen by Forel was *Orectognathus perplexus,* Sm. I suspected it to be identical with *Strumigenys antarctica,* Forel, and that Smith had wrongly counted the number of joints of the antennæ. Mr. W. F. Kirby did me the kindness to examine the type in the collection of the British Museum, and found that the antennæ are 6-jointed. The insect belongs therefore to the

* "Die Ameisen Neu-Seelands," in Mitth. Schweiz. entom. Ges., Bd. 8.

genus *Strumigenys*, and will henceforth be named *S. perplexa; S. antarctica*, Forel, being a synonym of it.

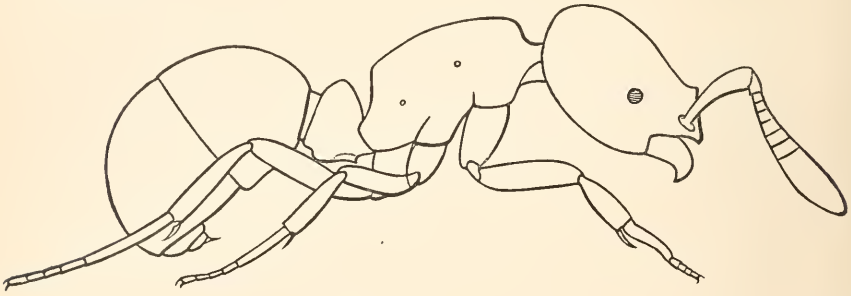
I describe here a new species belonging to the genus *Discothyrea*, which was established by Roger in 1863 for one species from North America. The occurrence of this genus in New Zealand is a further evidence of the cosmopolitanism and great antiquity of most genera of Ponerinæ.

Discothyrea antarctica, n. sp.

☿. Testacea, subtilissime punctata et tenuissime pubescens, pilis erectis omnino destituta, thorace superne convexo, haud marginato, metanoti pagina declivi subplana, marginata, superne minute, obtuse bidentata. Long., 2mm.

Found on Hunua Range, January 26, 1891, by Captain Broun, and sent by Mr. W. W. Smith. Three specimens.

The New Zealand species differs from the North American mainly by the laterally non-marginated thorax and the greater size. Roger's description is too incomplete to allow further comparison. I give an outline of the insect viewed from the side.



In respect to the generic characters, if we compare *Discothyrea* with the allied genus *Proceratium*, we must admit that the clypeus is reduced to form only the sharp edge of the disk-like produced forehead, the part which in other genera is wedged between the laminæ frontales being totally atrophied and the latter coalesced. The mandibles are triangular, with a concave, toothless inner edge terminated by a sharp point.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

Twenty-sixth Annual Report.

Meetings of the Board were held on the following dates: 11th July, 1893, and 15th February and 18th July, 1894.

The members elected, in conformity with the Act, by the incorporated societies as Governors of the Institute are Mr. S. Percy Smith, Mr. James McKerrow, and Major-General Schaw, C.B.

The members who retired from the Board, in conformity with clause 6 of the Act, are the Hon. Mr. Mantell, Mr. W. T. L. Travers, and Mr. E. Tregear; and these gentlemen have all been reappointed by His Excellency the Governor.

The vacancies caused in the roll of honorary members by the death of Sir Richard Owen and Professor Van Beneden have been filled by the election of Professor Thiselton-Dyer, M.A., C.M.G., F.R.S., Director of the Royal Gardens, Kew, and the Rev. Robert Henry Codrington, D.D., author of "Melanesian Languages," &c.

The members now on the roll of the Institute are: Honorary members, 30; ordinary members—Auckland Institute, 179; Wellington Philosophical Society, 134; Philosophical Institute of Canterbury, 66; Otago Institute, 111; Westland Institute, 67; Hawke's Bay Philosophical Institute, 94; Nelson Philosophical Society, 21: making a total of 702.

The volumes of Transactions now in stock are: Vol. I. (second edition), 250; Vol. V., 20; Vol. VI., 23; Vol. VII., 110; Vol. IX., 112; Vol. X., 142; Vol. XI., 33; Vol. XII., 40; Vol. XIII., 38; Vol. XIV., 62; Vol. XV., 173; Vol. XVI., 174; Vol. XVII., 176; Vol. XVIII., 150; Vol. XIX., 163; Vol. XX., 162; Vol. XXI., 96; Vol. XXII., 96; Vol. XXIII., 175; Vol. XXIV., 178; Vol. XXV., 180; Vol. XXVI., not yet fully distributed.

The volume (XXVI.) just published was issued in June, and contains seventy-three articles, together with addresses and abstracts which appear in the Proceedings. The volume contains 730 pages of letterpress and 54 plates. The following is a comparison of the contents of the present with those of last year's volume:—

	1894. Pages.	1893. Pages.
Miscellaneous	202	134
Zoology	258	260
Botany	88	82
Geology	76	36
Chemistry	...	6
Proceedings	64	50
Appendix	42	44
	730	612

The amount expended in printing Vol. XXV. was £388 9s. for 612 pages, and that for Vol. XXVI. £447 19s. 6d. for 730 pages.

In consequence of the large increase in the number of valuable works of reference and other scientific publications, it has been necessary to rearrange the books in the library, and to prepare a new edition of the printed catalogue. Good progress has been made with this latter work, which it is hoped will be ready for issue in a few months.

The splendid presentation by Mr. C. R. Carter of publications relating to New Zealand, containing 850 separate works, has now been thoroughly arranged and encased in a manner worthy of so valuable a donation.

The Honorary Treasurer's statement of accounts shows a balance in hand in current account of £96 12s. 6d.

The amount devoted to printing of memoirs and postponed papers (in accordance with resolution) is now £730.

Approved by Board. JAMES HECTOR,
GLASGOW, Manager.
Chairman.
18th July, 1894.

NEW ZEALAND INSTITUTE ACCOUNTS FOR 1893–94.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in hand, 11th July, 1893	61	16	0	Printing Vol. XXVI. ..	447	19	6
Parliamentary grant for 1893–94	500	0	0	Expense of library, cataloguing, &c. ..	48	0	6
Sale of volumes, late Trübner and Co., and in the colony ..	40	19	0	Foreign postage, freight on books, stationery, and miscellaneous ..	28	3	0
Contribution from Wellington Philosophical Society	18	0	6	Balance	96	12	6
	£620	15	6		£620	15	6

WM. THOS. LOCKE TRAVERS,
18th July, 1894. Honorary Treasurer.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting: *13th June, 1894.*

Major-General Schaw, President, in the chair.

New Member.—Mr. P. W. Tait.

A copy of vol. xxvi. of the "Transactions and Proceedings of the New Zealand Institute," and copies of the Proceedings of the Society for last year, were laid on the table.

Address by the President.—"The Last Glacial Epoch: explained by Major-General Drayson's Discovery of the Second Rotation of the Earth." (*Transactions*, p. 513.)

Sir James Hector proposed a cordial vote of thanks to the President. At the same time, as he had been specially asked to express an opinion, he must dissent from any view of the cause of the Glacial period that rested on the occurrence of astronomical cycles. Geological evidence was opposed to such regular cycles. The period since the great Ice Age in the north is quite insignificant compared with the immense time preceding, covering all the Tertiary and Secondary formations, during which evidence of extreme refrigeration is wanting. He described the glacial phenomena of New Zealand, which indicated a former greater extent and altitude of the land, with broad, lofty plateau-ridges that formed breeding-grounds for glaciers that have since eaten their way back, and converted the plateaux into sharp ridges and peaks. This, with the subsequent depression of the land, attended by changes in the distribution of shore-lines and ocean-currents, he thought, might be quite sufficient to account for the former great extent of glaciers in New Zealand. Of former glacial action, in the usual sense of the word, there was no evidence in the New Zealand islands.

Mr. Travers had great pleasure in seconding the vote of thanks, which was carried. He could not, however, agree with the views of Major-General Drayson either as to the causes for or the period at which the last glacial epoch took place. His views upon these points were entirely opposed to those of astronomers, geologists, and writers on biological matters, especially as affecting the distribution of plants and animals in the regions subjected to glaciation during that epoch; and it would certainly be extraordinary if such men as Laplace, Leverrier, Adams, the Herschels, and a host of other astronomical observers and writers who had dealt with the motions of the earth, should have altogether overlooked so important a matter as that which is involved in General Drayson's supposed discovery, or that such a discovery, though propounded nearly twenty years ago, should ever since have been, as it is, entirely ignored. It is suggested that this has been the result of jealousy; but it is impossible to suppose that the host of great men who have dealt with the question under discussion, and whose sole desire has been to discover the truth, could have been actuated by so unworthy a feeling if there had really been anything in it. The occurrence of the glaciation referred to, and its extent, are unquestionable. That it was partly due to astronomical causes and partly to changes in the distri-

bution of land and water has been clearly enough established by the writings of Croll, Geikie, and others, which are admirably summed up in Mr. A. R. Wallace's interesting work on "Island Life," in which he also gives a very complete account of the distribution of plants and animals within the area affected, and it is impossible to rise from the perusal of this work without being convinced that the causes mentioned were sufficient to bring about the effects investigated without resorting to such an hypothesis as that propounded by General Drayson. The General assumed, too, that the glaciation in question completed its retreat from the area affected within the historic period, for he fixed it at about eight thousand years ago. It would be curious if the area now occupied by England and Ireland—all of which, except a small portion of the more mountainous districts, was absolutely hundreds of fathoms deep below sea-level during the glaciation—should, when the Phœnicians traded to it, upwards of three thousand years ago, have been found inhabited by a race so far civilized as to carry on mining operations and the manufacture of metals, clothed with forest, and possessing a fauna since but little changed, but which had unquestionably for ages after the close of the glacial epoch been roamed over by the lion, the hyena, the cave-bear, the rhinoceros, and other animals not found in Europe for thousands of years anterior to the period of the Phœnicians' visits. These animals could only have found their way there when England became, on its re-emergence, united with the Continent of Europe by a tract of intervening land, which has since disappeared owing to a fresh subsidence. The commencement of the glacial epoch in the Northern Hemisphere has been fixed by Croll and others at about 260,000 years ago, and its termination at about 80,000 years ago, for during the whole of the intervening period the eccentricity of the earth's orbit was at its maximum, and winter occurred there when the sun was in aphelion. These, combined with matters affecting the then distribution of the land and water within the districts affected, seem fully to account for the occurrence of the glacial epoch; and much more cogent grounds than those advanced by General Drayson would be necessary to displace those upon which the authors referred to have based the views they have propounded.

Mr. Blair said that there were two works lately published by Sir H. Howorth, K.C.I.E., F.R.S.—viz., "The Mammoth and the Flood" and "The Glacial Nightmare"—which threw quite a new light on this glacial question, and which the President had not seen. He would also call the President's attention to the remarks on these works in the *Quarterly Review* of January, 1888, and January, 1894. There seemed to be great difference of opinion on the subject, and it had been by no means settled. Instead of glacial action, we must look to that of water and snow.

Mr. M. Chapman had a great deal to say on the subject; but, unfortunately, there was no time at present.

General Schaw remarked that General Drayson had stated facts, and no one had yet contradicted them, and he did not think they could.

SECOND MEETING: *27th June, 1894.*

Major-General Schaw, President, in the chair.

New Member.—Mr. A. R. Atkinson.

Papers.—1. "On the Abundance of *Vanessa itea* in Wellington during Season 1894," by W. P. Cohen. (*Transactions*, p. 281.)

Mr. Travers said he thought that this was the same butterfly that Mr. Hudson called *Pyrameis*. He had met with it often in Wellington and other places in New Zealand.

Mr. Hudson said that *Vanessa* was the old name and *Pyrameis* the new. There was a slight difference in the wings. *V. itea* was found in New Zealand and Australia, and *Pyrameis* in New Zealand only.

Mr. Maskell said he was glad to see a young member presenting a paper of this kind. Mr. Cohen had some good collections, and frequently exhibited them at the meetings; but this was the first time he had communicated his observations to the Society.

2. "Illustrations of Darwinism; or, The Avifauna of New Zealand considered in relation to the Fundamental Law of Descent with Modification," by Sir W. Buller, K.C.M.G., F.R.S. (*Transactions*, p. 75.)

Mr. Maskell did not intend to discuss the paper at length, as he could not follow distinctly the whole of the paper. In dealing with the subject he did not think the author had gone below the surface. He had not contradicted any of the fundamental arguments against the Darwinian theory. He thought it a great pity that the author had referred in the manner he did in his introduction to the papers by the President and Mr. Coleman Phillips—personality on such occasions should be avoided as much as possible, and members should not be held up to ridicule. He would recommend the author to withdraw the remarks in the introduction before he submitted it for publication.

Mr. Travers said he was a follower of Darwin's doctrines, and he had made many observations similar to those mentioned by Sir W. Buller on the subject. He mentioned the disappearance of forms of life which occupied a conspicuous place in former years, and he referred to instances of variation of form, plumage, and colour that he had observed in plants and animals. He did not think the paper just read contained views that would excite controversy. There was nothing really very new in it.

Mr. Field described specimens of birds in New Zealand which are quite different from anything described in Sir W. Buller's work on the birds of New Zealand, especially as regards colour, and this, he thought, would favour the development theory. He mentioned many instances of this in ferns and other plants.

Mr. Carlile, as an outsider as regards natural science, said he would not have presumed to intervene in a discussion of this sort if it were not that Darwinism had now taken possession of the whole field of human knowledge. It had given a human interest to science. Nowadays, when one endeavoured to follow such a discussion as the recent one between Weismann and Herbert Spencer, on such a point perhaps as the cause of the change of structure in the heads of the soldier-ants, he found that he was really engaged on a question that had an interest bearing on important social problems. It bore, for instance, on such a question as that of whether habitual drunkenness could be inherited or not. The greater interest nowadays attaching to science would probably secure for it in the future that leading position in the curricula of our universities that had been often claimed for it. Evolution was one thing, but evolution by means of purely fortuitous variations was another. Sir W. Buller had adduced the case of protective colouring as a case of Darwinian evolution. It was, however, rather a difficulty in the way of the acceptance of the theory. One could understand how even the smallest degree of added swiftness in a young fish would assist it to escape its enemies, and so tend to the perpetuation of the type; but it was impossible to understand how the initial stage in the variation—from brown to green, say—could have any preservative effect at all.

Mr. Tanner said he did not think the question of Darwinism could be discussed without the display of a considerable amount of feeling. He did not think Sir W. Buller's remarks at the opening were intended to hurt any one's feelings.

Mr. R. Pharazyn thought the paper a most interesting one. He thought it was quite possible to convince people that the Darwinian theory was sound. He agreed generally with the views expressed in the paper.

General Schaw took the author's views on the subject, which were opposed to his own, as merely a friendly attack. He did not think Sir W. Buller had brought forward sufficient evidence to prove the views he advanced. He himself was a believer in evolution, but only as far as theory was supported by facts. There was no evidence of steps leading up to the development referred to by Sir Walter Buller; we had not yet got hold of the whole facts of the case; there was still something required in addition to Darwin's views to make the matter plain—some great laws, as yet unknown, in obedience to which new types of life had appeared.

Sir W. Buller, in reply, said it was hardly necessary to disclaim any intention of reflecting offensively on the President or any member of the Society. The common-sense of those present would bear him out in that. The President had, in his inaugural address, thrown down the gauntlet, and openly invited discussion. He had seized the first opportunity of meeting that challenge, and he hoped that both the President and Mr. Maskell were prepared to fight for their views. For his own part, he would always be ready to combat to the utmost of his power doctrines which he regarded as unorthodox in the light of modern science. Had he sat silently by and allowed such views as those he had criticized to go forth in our Transactions unchallenged he would have felt self-convicted of moral cowardice. His duty to a society which had honoured him by election to the presidential chair four times over, his duty to science, and his duty to the memory of the great and good Darwin, who twenty years ago had been one of his (Sir Walter's) proposers for the Royal Society, all required that he should speak out with no uncertain sound. He added that the President, in the explanatory observations he had made that evening, following the lines of his former address, had opened up new debatable ground; but the hour was too late to admit of anything further being said on the subject.

Sir James Hector drew attention to a series of most interesting photographs of Rarotonga, kindly exhibited by His Excellency the Governor, Lord Glasgow (who was present); also some moa-bones found by Mr. Donne in the Wairarapa district.

THIRD MEETING: *11th July, 1894.*

Mr. W. M. Maskell in the chair.

New Members.—Rev. C. S. Ogg, Mr. H. P. Hanify, Mr. H. N. McLeod, and Dr. Adams.

Papers.—1. "The Humist Doctrine of Causation in its Relation to Modern Agnosticism," by W. W. Carlile, M.A. (Printed in *Mind*, vol. iv., No. 13.)

ABSTRACT.—The following are the subjects dealt with in this paper:—Part I.: (1.) The Criterion of Truth in Philoso-

phical Discussion. (2.) The Truth of Facts and the Constitution of Conceptions. (3.) The Type-instance of Reality. (4.) The Extension and Attenuation of Meaning. (5.) Transition from Literal to Metaphorical Meaning. (6.) Connotation of Everything.—Part II.: (7.) State of the Controversy. (8.) Relation between Knowledge and Reality. (9.) The Type of Causation. (10.) Constant Causes. (11.) Uniformity of Nature. (12.) Force and Causation. (13.) *Vires acquirit eundo.* (14.) Properties of Artificial Objects.

Sir James Hector thought it unfair to discuss such an elaborate paper without more consideration: in fact, he had not clearly caught which line of thought the author supported. The existence of a necessary sequence in cause and effect was required by modern science; and those who led in the metaphysical aspect of the subject must be careful of their premisses. He thought several of the physical illustrations given might prove fallacious on close examination. While he approved and admired the paper, he thought that such discussion should not be mixed up with truly practical science, which is the disentanglement of complicated sequence of cause and effect, and not the discussion of an ultimate cause.

The Hon. R. Pharazyn said that, in spite of the old Scotchwoman's opinion, there was much truth in the assertion of a great authority that "all physical questions ultimately resolved themselves into metaphysical ones," in the sense that in any phenomenon we had to determine how much was objective and how much belonged to the mind of the observer. There was a kind of metaphysics which ignored experience, and which Mr. G. H. Lewes called "metempiric," which was useless and led to no results. As Professor Max Müller had well said, "To know a thing by itself is to know it not as we know it, but as we do not know it, which is self-contradictory." The great principle of science was that all real knowledge was relative, and relative in two ways: first, in relation to one's own mind; and, secondly, in relation to things. As Professor Bain says in his "Logic," "We think of all things in pairs—large and small, light and dark, hot and cold, and so forth." Then, what was meant by a scientific explanation of any fact but referring it to some more general fact known to us by experience? This applied to our most familiar conclusions. If in the stillness of the night we hear a scratching, gnawing sound we immediately say rats or mice caused it, though, indeed, some people might say ghosts, but, knowing nothing of ghosts, that would not occur to him. Now, looked at in that way, and considering that experience was our only guide, he thought Mr. Carlile's paper, ingenious as it was, had entirely failed to upset Hume's and Mill's theory of causation. All we know of cause and effect is invariable sequence; and he agreed with a writer who said that for scientific use "law" was a better term than "cause." As to the contention that mind was the ultimate cause of things, he feared he should be trenching upon theology if he discussed that question; but he might say that there was a logical weakness in the argument from design. Put into the form of a regular syllogism, it was usually stated thus: "Whatever shows marks of design must have had a designer. The universe shows marks of design; therefore the universe must have had a designer." This, he thought, was syllogism in the first word of the first figure, and its major premiss was, "Whatever shows marks of design must have had a designer." Now, Mill had demonstrated that the major premiss of every syllogism is an inductive assertion. Now, in this case our induction is based upon human experience only—an experience extremely limited as compared with the universe at large. Paley's "watch argument" rested on the fact that we know that watches and such

things are made by intelligent beings; but what reason have we for supposing that mind or intelligence is the sole cause of the existence of things which seem to show marks of design? The conditions of existence necessitate certain relations which look like design, and yet, apart from other considerations, may be nothing of the sort.

Mr. Tregear said he considered that almost all metaphysical discussion arose from the fact that the medium through which our thoughts were conveyed was the imperfect one of words. Words were sometimes beautiful things in their long history and adaptation, but they were, after all, things which were our heritage from barbarian forefathers, and not perfect tools by any means. Metaphysics, so long as we use words, was like the effect of elaborate fencing-rules being followed by people armed with the weapons of the Stone Age. Mr. Carlile's notion, of course, was not tenable. He was not himself a cause, except as an intermediary cause, himself the sum of infinitely numerous effects. The cat quoted by Mr. Carlile as having removed some slippers was not to be regarded as anything like the real cause: behind the cat were the cat's father and mother and their fathers and mothers *ad infinitum*. Science could only look for intermediate causes and effects; the final cause might be conceivable, but was not within the domain of knowledge or field of science. Every intermediary cause had millions of effects, which in themselves became causes in turn, and made investigation as to finality impossible. He (Mr. Tregear) denied the doctrine of "design" as inferred and mentioned by Mr. Carlile. If one took up a board on the floor and found that it had once been varnished and beaded as a desk it would be reasonable to suppose that it had not always been a flooring-board. So, when the President had said that "a whale was always a whale," he (the speaker) did not agree with him. The whale had within his body two leg-bones, rudimentary and tiny now, with which he had once walked. So did the boa-constrictor. Man had his tail-bones tucked in and useless, the muscle in his cheek with which he once pricked forward his ears, the pituitary body in the brain through which he had once breathed water, the intestine (dangerous as well as useless now) which in the horse was a valuable organ. Man was just a "second-hand" animal; the evidence proved that he had once other uses, just as the polished board proved that it had not been always a floor-board. Man, as man, had been adapted, not designed.

Mr. Hawthorne referred to the rules of the Society to show that such a paper as Mr. Carlile's should not be read before the Society, as it touched on religious subjects. On hearing such a paper members were lost in a maze of unprofitable speculation. He thought it would be better if more attention was paid to natural history.

Mr. Harding disagreed with the last speaker. He thought that Mr. Carlile's paper dealt with a subject quite within the sphere of the Society, and with his general conclusions he was disposed to agree. Here, as in other debatable matters, one of the chief difficulties and causes of misunderstanding arose from the imperfection of language as an instrument of thought, and arguments and supposed facts to a great extent resolved themselves ultimately into disputes about definitions. The argument from "common-sense" was sufficient to dispose of the more unprofitable metaphysical subtleties, and was a safeguard on the one hand against individual hallucination, and on the other against the wilder flights of the unrestricted scientific imagination. The ideas of conception and object of conception and the thing conceived were so clearly separable that it was only by considerable mental effort that they could be confused. It was so also with the idea of a chain of cause and effects—of consequence as distinguished from mere sequence. A first cause was doubtless beyond the sphere of physical science, but had been of necessity assumed by philosophers of all ages; and rightly so, for, reasoning by analogy, as had already been pointed out by our President, we found that every develop-

ment of force in the human sphere, from the movement of an eyelid to the course of an express train or an ocean-steamer, could be traced back to what was known as will, and could be followed no further.

Mr. Tanner said it seemed to him that when dealing with metaphysics it was difficult to come to a common understanding. The paper was most interesting, but it appeared almost impossible to arrive at any satisfactory conclusion on such a subject.

Mr. A. R. Atkinson remarked that the difficulty in dealing with a subject like this was largely one of language. Words in general were not constructed with precision for the purpose of science, but roughly hewn for popular use; and, after their being so manufactured, the philosopher had to make the best use of them he could. The chief objection which a philosopher would take to Mr. Carlile's paper would probably be that there was too much common-sense about it. In ordinary language our view of the "cause" of a thing was determined by the particular aspect of it that had most interest for us at the time; but was it possible, philosophically, to separate the cause of anything from the whole antecedent history of the universe? Similarly, the doctrine of the conservation of energy showed that, scientifically speaking, no cause can ever cease to operate. This seemed to be the explanation of the argument which the author based on Newton's first law of motion. In conclusion, he protested against what he took to be the suggestion of a previous speaker —namely, that a subject of this kind lay beyond the scope of the Society.

Mr. Barnes also agreed with other members as to the great difficulties attending the discussion or conception of a question of this nature, and gave as an illustration a chain of circumstances showing how an occurrence or event might be traced back through the chain to a cause having apparently not the slightest or remotest connection with it. It seemed to him that all existing circumstances were the progeny of pre-existing circumstances, which was perhaps only another way of saying that "the cause of anything is the previous history of the world."

Mr. Carlile, in reply, said if a subject such as this was barred as unsuitable for the Society they would bar everything that had been written on the subject of philosophy as distinguished from special science, from Plato to Hegel. If agnosticism was proved untenable, the crude teleology of Paley was not the only alternative explanation of the universe. There were other explanations which did not leave reason out of account, such as that attempted to be given by Hegel. It was quite legitimate, in any case, to show the fallacy of one system, without having another system ready-made to substitute for it.

2. "A Chapter in the History of the Warfare against Insect-pests," by W. M. Maskell, F.R.M.S. (*Transactions*, p. 282.)

In the course of his paper the author referred to the fact that Dr. C. V. Riley had been obliged, through failing health, to resign his appointment as Director of the United States Agricultural Department (Entomological Branch), and pointed out that the farmers and cultivators of every country of the globe were indebted to him for his services during the past thirty years.

On the motion of Mr. C. V. Hudson, seconded by Sir James Hector, the following resolution was passed: "That the members of this Society sympathize cordially with Dr. Riley in his enforced retirement, on account of ill-health, from the position of State Entomologist to the United States, and beg to assure him of their high appreciation of the services which he has rendered during the last thirty years to cultivators of every country."

FOURTH MEETING: *25th July, 1894.*

Mr. C. Hulke, Vice-president, in the chair.

New Members.—Mr. Robert Orr, Dr. H. Pollen, Mr. E. F. Hadfield.

Papers.—1. "On a New Species of Fern-bird (*Sphenœacus*) from the Snares Islands; with an Exhibition of Specimens," by Sir W. L. Buller, F.R.S. (*Transactions*, p. 127.)

2. "Notes on the Flightless Duck of the Auckland Islands (*Nesonetta aucklandica*)," by Sir W. L. Buller, F.R.S. (*Transactions*, p. 128.)

3. "Notes on the Ornithology of New Zealand; with an Exhibition of Rare Specimens," by Sir W. L. Buller, F.R.S. (*Transactions*, p. 104.)

Sir James Hector asked if the differences between the various species of the outlying islands exceeded the limits of variation within New Zealand itself. For instance, the Chatham Island pigeon on the table does not appear to vary from the normal so much as several specimens in the Museum. The Antipodes Island parrakeet is, no doubt, distinct, but the supposed representative species of the New Zealand red-top seems very doubtful. The change of name of the North Island woodhen is also only founded on slight difference of plumage; yet he had seen in the south-west coast black woodhens with three red and four black chicks nearly full-grown. The Chatham Island pukeko is another case of a species determined on very slender plumage characters. He would like to see more attention paid to characters derived from the internal anatomy of birds in their classification. He admired Sir W. Buller's inference respecting the climbing habits of the flightless duck of the Auckland Islands, and no doubt the skeleton of that bird will show evidence of its modification and adaptation to this novel mode of progression. To make a new species he held that divergence from the type must be due to influences extending over a long period of time and in an isolated locality.

Mr. Hulke was glad to hear Sir W. Buller protesting so strongly against the wholesale destruction of our native birds. They certainly should be protected. Those beautiful birds the tui and the bell-bird were fast disappearing.

Sir W. Buller, in reply, said that Sir James Hector's remarks had raised the old *quæstio vexata*, What is a species? It could not be denied that the line of demarcation between species and varieties is and ever will be an uncertainty. As he, the speaker, had pointed out on a former occasion, the "species" of one naturalist is the "subspecies" of another, and the "local variety" of a third. Sir James Hector's observations as to the difficulty of distinguishing between the black woodhen and the brown woodhen in the South Island was a case in point. Several species of this genus appear to run into one another by almost insensible gradations, and it is extremely difficult to draw the line between them. As to the amount of constant difference sufficient to distinguish one species from another, that too is an uncertain quantity, for it is practically at the discretion of the expert, and few experts are in exact agreement on this point. All this goes to prove the existence of transitional forms or "incipient species." Sir James Hector had expressed his belief that external characters, such as the colour of the plumage, and so forth, were of very little value as compared with the anatomical structure. That

was perfectly true, but it would be found as a rule that the external characters, such as the bill, feet, and wings, were but a reflex of the internal organization; they must of necessity harmonize with each other, the one being, in fact, the index of the other. For his own part, he considered that, whatever might be the system of classification, it was impossible to attach too much importance to the anatomical structure of animals. In his opinion, as to the class Aves, there never would be a perfect system evolved till the œsophagus and intestinal canal, as well as the osteological framework, of every bird had been completely investigated by ornithologists, as that of the common rock-dove (*Columba livia*) had been by the late Professor McGillivray. As to the small amount of specific difference distinguishing these island-forms from those inhabiting the mainland, this only went to prove that at no very remote date in the past there was a parent species from which these various forms had sprung, the differentiation of character having been caused, under the operation of natural laws, by the insulation of the descendants for the necessary period of time. For example, roughly speaking, each group of islands possessed its own parrakeet, but these were so closely related to one another that some naturalists regard them all as mere local varieties of the typical *Platycercus novæ-zealandiæ*. Be that as it may, no one can doubt a common parentage. The case is different as between *P. unicolor* and *P. erythrotis*. Here we have two parrakeets, possibly generically distinct, living side by side on Antipodes Island, a mere rock in the midst of the ocean. The larger form, *P. unicolor*, has been there long enough to become highly specialized in its structure and habits, having, as we see, become admirably adapted to its natural environment. The other form, *P. erythrotis*, differs so slightly from *P. novæ-zealandiæ* that some ornithologists refuse to accord it separate specific rank. As he had explained on a former occasion, he could only account for the co-existence of the two species by assuming an accidental colonization of the rock by the smaller red-topped form at a comparatively recent date. As to Sir James Hector's criticism with regard to Mr. Rothschild's *Carpophaga chathamensis*, he (the speaker) could hardly agree. He had himself shot hundreds of the New Zealand wood-pigeons, and he was willing to admit that within early limits there was much individual variation. But that was something very different from the presence of constant specific characters, however slight. He would undertake to pick out a Chatham Island wood-pigeon from a hundred New Zealand birds, the difference of plumage being sufficiently pronounced to make the bird readily distinguishable from *C. novæ-zealandiæ*. That both birds had originally come from the same stock he had not the slightest doubt. But, if we are to regard specific characters at all, then for the purposes of classification we must treat the Chatham Island pigeon as distinct from our own. If a so-called "species" passes the ordeal among expert ornithologists at Home, and is generally accepted as such, we cannot lightly ignore the distinction; but the very doubt raised by Sir James Hector bears directly on the question of descent with modification. Dr. Sharpe's *Porphyrio chathamensis*, referred to by Sir James Hector as a case in point, seemed to him entirely different; for this was just one of those ordinary instances of individual variation. If, on the other hand, all the specimens from the Chatham Islands had exhibited the peculiarities in coloration of Dr. Sharpe's specimen, he (the speaker) would have been willing to admit it as another illustration of the creation of insular species by natural means. As he had pointed out, however, that was not the fact.

4. "On the Anatomy of Flight of certain Birds," by Sir James Hector, F.R.S. (*Transactions*, p. 284.)

Mr. Tanner asked if it was true that the penguin could only move

in the water with its wings. He could quite understand from what Sir James Hector had exhibited how the albatros only used the tips of its wings for turning and directing its flight.

Mr. M. Chapman said the problem of the flight of the albatros is one of the most interesting that could engage the attention. It was not to be solved either by anatomy or mathematics, though both may probably assist to throw some light on the question. There is, however, more to be hoped for from observations or experiment. He had watched albatroses and similar birds hour after hour and day after day, and had been unable to come to any other conclusion than that they utilized upward currents of air. These upward currents are caused by the deflection of the wind from the backs of waves. They can be seen in a gale of wind by the showers of spray which fly upwards from breaking waves. On the islands where they breed, they choose their breeding-grounds on the bleakest and most exposed parts of the island, at a great elevation—1,000ft. and upwards. They cannot rise from the ground without wind, but do so with ease in a strong wind. In a light breeze they rise by violent exertion, barely able to maintain themselves, but make for the edge of the cliff, where the wind, striking the precipitous cliff-wall, makes a strong upward current, and the moment the bird gets into this current it shoots upward 100ft. or more in a moment, and is immediately master of itself. Flying at sea they may constantly be seen to dip into the trough of the sea, choosing that moment to turn to windward and rise. In flying to leeward they descend, accelerating their speed. In turning, the end-joint of the wing is bent, as if to avoid touching the water, but possibly to virtually shorten the wing. Another interesting problem was the question as to how the albatros feeds. He had seen an albatros on shore disgorge a large pelagic squid which must have weighed several pounds, and the castings of cuttle-beaks at their nests show that this is an important item of their food. But he had never seen one pick up anything while on the wing, or alight to feed except on offal thrown from a ship. They get little of this, as they first take a look at speed, and then have to make a wide sweep before they can alight at the spot. By this time the smaller birds have devoured the food.

Sir W. Buller said he had listened with great interest to Sir James Hector's paper on certain features in the anatomy of New Zealand birds. He would now ask Sir James whether the peculiarities of structure, showing adaptation to the environment of the species, so ably discussed in his paper, could be accounted for on any other hypothesis than that of natural evolution.

Sir J. Hector replied that the whole of the facts put forward by him supported that theory.

Sir W. Buller, continuing, said that, although Sir James Hector's description of the mechanism of the wing of the albatros was very instructive, and his theory in regard to the flight of this bird was a very ingenious one, he did not think we had yet quite solved the problem. The flight of the albatros was very wonderful, not only in its majestic sweep, even against the wind, but in its being so long sustained. When voyaging on the high seas he never tired of watching this untiring flight —to use Froude's expressive language—"sweeping past in a long rapid curve, like a perfect skater on an untouched field of ice." He mentioned a case within his own observation of an albatros performing a continuous flight of 3,000 miles (see Trans. N.Z. Inst., vol. xxvi., p. 185). He agreed with Mr. Chapman that the feeding-habits of this bird still required explanation.

Sir J. Hector replied that he only looked on the fact he had stated as one of the factors in enabling the sustained flight of the albatros. It only suggested the mechanism by which the bird can take advantage without fatigue of the other causes indicated by previous writers and

those who had previously spoken. With reference to the supposed abstinence from food, he conjectured that the albatros was a night-feeder, and was enabled to capture its chief prey, the cuttlefish, by its phosphorescent luminosity, which must make it easier seen and captured in the dark than in the daylight. The penguin uses its wings in the water for swimming.

Fifth Meeting: *8th August, 1894.*

Sir James Hector in the chair.

New Member.—Major E. H. M. Elliot.

Papers.—1. "On Ceremonial Language," by E. Tregear, F.R.G.S. (*Transactions*, p. 593.)

Mr. Maskell said he was not an admirer of Mr. Tregear's theories, but he was one of the men who had done most to lay before the Society facts which without his industry would not have been known to those south of the line. He believed every fact brought to our notice by Mr. Tregear, but he did not agree with the theories he founded his facts on. There might, perhaps, be an explanation of the ceremonial language that had not occurred to Mr. Tregear—namely, that in the human heart there lies an essential acceptance of the fact, which is denied by modern liberalism, that all men are not equal; and this may account for the universal prevalence of class distinctions, inferior and superior.

Mr. Coleman Phillips said that if any one saw the chiefs and the common people on the islands they would observe that they are quite different. The common people look like slaves and the chiefs like nobles in comparison, both physically and mentally; and their language is quite different. This will be seen in their old songs; but the dialect has altered much, as in England. Is it in the alteration of the dialect that the difference in language arises? The people remain the same, but the language has altered in course of time.

Sir James Hector suggested that one cause for the gradual change in language was due to the fact that certain words became *tapu*—as, for instance, the name of a fish or bird—on the death of a chief who was called by the same name.

Mr. Tregear, in reply, said it was true, as Sir James Hector had said, that words got out of use through being *tapu* when forming parts of chiefs' names. This is the custom throughout the whole Pacific, and it is likely (as explained in the paper) that after a time the disused words might grow into a kind of chiefs' language, not to be used by the common people. It happened, however, that the *tapu* on such words only exists during the life of the chief in whose name they appear. The substituted words are not gibberish or foreign words; they are pure Polynesian, and without historical interest. It is a fact, as Mr. Phillips has said, that in some of the islands the chiefs are invariably superior in physique to the common people, but there is no substantial ground for the theory that these men are aristocracy because representing the conquering race, as the Normans did in England. The chiefs' families are people having large bodies (sometimes far too fat), because they are better fed than the others, and their direct forefathers have also been well fed. No hereditary racial difference between them and the common people has been established. Ceremonial language could not certainly be attributed to the cause suggested by Mr. Maskell—namely, that there was an inherent and instinctive division of mankind into superior people and inferior, necessitating that language should adapt itself to such feelings. These

courtly languages under discussion were comparatively modern inventions. Those of the Malay Archipelago savoured more of the influence of the priest than of the soldier. As India shows to us, when a language outgrows active life it fossilizes; it becomes the property of the religious bodies, and its more sprightly children are adopted by the people. In Java this shows out plainly, where we find the original native words superseded by the Sanscrit and Pali brought by the priests of Buddha, in its turn overlapped by the Arabic of the Moslem. If Polynesians passed through the Malay Archipelago, as they almost certainly did, they passed through long before the courtly language of Java was invented, and consequently could not have acquired it from the islanders.

2. "On the Milk-supply of Wellington," by C. Hulke.

Mr. Maskell said we owed a debt of gratitude to Mr. Hulke for his able and interesting paper. He thought it was a matter for congratulation that nothing worse than adulteration by pure water had been discovered in the analyses of the various milks. He had feared that our milk contained deleterious substances of various kinds. He would like to know how the ordinary consumer could discover when milk was adulterated.

Mr. C. T. Richardson said that, as the majority of young New-Zealanders were brought up on cows' milk, it was certainly not beneficial to them if adulterated with water.

Mr. R. J. Barnes would like to know if it would be possible to adulterate milk with mutton or other fat, as he had heard of this being done to obtain a supposed heavier cream.

Sir James Hector said the elaborate chemical tests so ably described by Mr. Hulke might be necessary for enforcing legal proceedings, but the simple test of the proportion of cream by means of a graduated tube was enough for ordinary purposes. The danger arising from adding water to milk depended on possible impurity of the water used. He had seen aquatic larvæ of blow-flies introduced into milk in this way. Low specific gravity does not always indicate bad or watered milk, as the amount of nourishment in the grass at different seasons greatly affects the quality, and especially the proportion of butter-fat it contains.

Mr. Hulke, in replying, stated that he had not said that the milk was adulterated with *pure* water. The question about mutton or other fats being used need not be entertained at all. Mr. Hulke wished farmers, dairymen, and milkmen generally to be educated up to the fact that the cow was a machine, man the manufacturer, and it depended upon the goodness of the machine or the material put into it as to what the manufacturer would get out of it. He would like to see a clause in the Bill now before Parliament altered to read "normal-quality milk" instead of "pure milk," as so-called pure milk may often be very poor milk, and not good for butter; and the standard quality should be fixed at from 11 to 12 per cent.

A number of exhibits were shown at the meeting by Sir James Hector; and Mr. T. Kirk exhibited a collection of mosses, and also a beautiful yellow flower, a new arrival in New Zealand, from Mr. Duncan's nursery at Porirua—(*Euryops abrotanifolius*, DC.)—a native of the Cape of Good Hope. It produces its bright flowers in vast abundance during the winter months—June to September.

Sixth Meeting: *22nd August, 1894.*

Mr. E. Tregear in the chair.

New Members.—Dr. Teare and Mr. J. P. Campbell.

Papers.—1. "On a Recent Discovery by Mr. Donne of Bones of *Dinornis giganteus*, on the Surface," by Sir James Hector.

Sir James Hector exhibited some moa-bones found by Mr. T. E. Donne in the Wairarapa district. The chief interest is from the position in which these bones occur. Mr. Donne says that "when deer-stalking on the 10th April last he found the bones on the top of the Maungaraki Range, seven miles eastward of Gladstone. They were lying on the surface on the top of the mountain, and free from bush. Some were exposed to the air, but others were covered by a heavy growth of thistles. None were covered by earth. They had evidently lain in the same position for a long time. No traces of old native encampments were found in the vicinity." The bones are the right and left femora of *Dinornis giganteus*, and the right tibia and tarso-metatarsus of the same bird. The fibula is not present, but the diagram sketched by Mr. Donne shows that the tarsal bone has been rolled over without disturbing the relative positions of the other bones. This observation is supported by an examination of the weathered surfaces of the bones, and there can be little doubt that the bones have been lying undisturbed on the surface since the bird died. This remarkable discovery has suggested the comparison of the degree to which mineralization of moa-bones has been effected, as compared with the mineral contents of recent bones of struthious birds. Omitting water, which is variable according to the nature of the material in which the subfossil bones were imbedded, we have the following:—

—	Organic.	Inorganic.
Recent.		
Ostrich, femur	34·86	60·14
Emu, femur	36·67	63·33
Subfossil.		
Dinornis rheides, Timaru Cave	35·65	64·35
Dinornis ponderosus, Maniototo (dry swamp)	25·31	74·60
Dinornis validus, Glenmark	29·95	70·05
Dinornis struthioides, Glenmark	24·18	75·82
Dinornis giganteus, Wairarapa (surface) ..	24·10	76·90
Dinornis potens, Shelter Rock, Clyde ..	18·25	81·75
Dinornis casuarinus, Highfield Cave ..	14·70	85·30
Dinornis didiformis, in pumice-sand ..	14·40	85·10
Cnemiornis didiformis, Highfield Cave ..	14·70	85·30
Dinornis didiformis	25·99	74·01
Dinornis struthioides	37·86	62·94

Attention was drawn to the wonderful discoveries of bones on the surface in South Australia. Under sand-dunes 30ft. in height, far in the interior and round the margins of desiccated lakes, there is a 3ft. deposit of yellow and blue clay resting on sharp sand which is full of bones of extinct animals. The deposit is fifty miles long by five to ten miles wide; but similar deposits have now been found in other parts of Australia. Most of the bones belong to extinct forms of marsupial Mammalia, but

some large forms of birds have also been discovered. They are, however, very different from our New Zealand forms, as may be seen from the following comparison :—

	Australian.	New Zealand (Dinornis).
Skull, length	12in.	1·4in. to 3·8in.
Femur, „	12in.	6·0in. to 18·5in.
Tibia, „	24in.	10·1in. to 39·0in.
Tarsal, „	14in.	4·8in. to 21·5in.
Wings	Complete	None.

Mr. Travers supported Wallace's views in reference to the condition of Australia in Pliocene times. There was, no doubt, a land-connection between New Caledonia and New Zealand, which would account for the large birds found here. There is evidence of such a land-connection between eastern Australia and New Zealand where the sea is shallow. The occurrence of the moa-bones found on the surface no doubt goes to prove that the moa did exist within a comparatively recent period.

Mr. Phillips said that bones such as those mentioned would, if in the open, last a long time; but in the bush or in a stream they would soon decay. He thought the moa had been seen during Maori times. He had called Sir James Hector's attention to the *Diprotodon*. He thought the dry climate would account for this preservation. Why should the moa die out, and the emu and other large birds remain? He agreed with Mr. Travers regarding the former land-connection.

Mr. Hudson called attention to Mr. Darwin's observations regarding the time it required for bones or other objects on the surface to become buried by earthworms: possibly his observations would make it possible to arrive at a more exact date for the disappearance of moa-bones.

Mr. Tanner thought that the moa did exist in Maori times. Lots of well-preserved bones had been found on the banks of the Oreti River, in the old Maori cooking-ovens—even the delicate neck-bones, which could not last very long on the ground.

Mr. McLeod thought it would be a good thing to have the earth in or on which the bones were found analysed, to ascertain if it contained anything that would prove that bones had been buried there.

Mr. McKay said the Maoris might have seen the moa thirty years ago, especially judging from the bones on the table. The bones might have been buried, and exposed afterwards. They had been found at Benmore, in the south, on the bare rock, and they could not have remained there long without decay.

Mr. Tregear said that, as he was the only representative present of the "traditionalists" in the moa controversy, he would say a few words. When geologists made a distinct statement that such and such moa-bones were found on the surface, there could be no debate; positive statements by experts had to be received without question. But what those who thought with him refused to accept was a large quantity of so-called evidence that the Maoris had ever known the *Dinornis* as a living bird. On the contrary, there was strong evidence for thinking that, whoever the natives were that had assisted in destroying the *Dinornis*, the Polynesian Maoris had not. The very word "moa" (whatever it meant) was alluded to as "lost" in a song of ancient days—one of the oldest songs collected in the South Island by the Rev. Mr. Stack. Why allusions should be made by Maoris to the moa having perished centuries ago, if it was still alive during the last thirty years, is one of the things which are hard to explain.

Sir James Hector, in reply, said it was well to keep this subject alive. Both sides had yet to ascertain how the matter really stands, and it would be well for observers to note the exact position of bones found in various localities, and the kind of soil in which they occur, for bones become quite different under different circumstances of deposit. The

question should not be considered closed by either party. Mr. Mantell had lately found a letter from Professor Owen to his father, enclosing the professor's first paper on the moa, and he says that there is less information in it regarding the moa than he (Mr. Mantell) could obtain at that time from many natives on the beach.

2. "Notes on the Larger Species of *Paryphanta* in New Zealand, with some Remarks on the Distribution and Dispersal of Land-shells," by W. T. L. Travers, F.L.S. (*Transactions*, p. 224.)

Sir J. Hector had a number of the Picton shells alive for some time; he did not think they were carnivorous. He thought we had only two species, and the difference in colour depended on the colour of the trees on which they live.

Mr. Hudson said this was a most interesting and instructive paper.

Mr. Travers, in reply, said what he wished to call attention to was the wide distribution of these shells, which had not been sufficiently considered in making collections.

3. "On a Method of Cure in Germ-diseases," by R. J. Barnes.

Dr. Teare said it was an ingenious paper; but he was afraid there were several points in it that would not be agreed to by the profession. Mr. Barnes was unfortunate in selecting typhoid fever as the disease to be cured, as that recurred.

SEVENTH MEETING: *5th September, 1894.*

Mr. C. Hulke, Vice-President, in the chair.

The Chairman announced that the Australasian Association for the Advancement of Science would hold their next meeting at Brisbane, on the 11th January, 1895, and the usual concessions would be made by the shipping companies and the railways to members visiting.

Papers.—1. "Note on the Aurora Australis, as observed at Karori, Wellington, on the 20th August, 1894," by G. V. Hudson, F.E.S.

ABSTRACT.

The author first noticed this aurora at 7 p.m. as a strong whitish light along the southern horizon, somewhat resembling the earliest traces of the dawn. This light steadily increased, gradually forming itself into a shaded arch, which extended from the south-east to the south-west. Below this arch the sky appeared extremely dark, as if heavily clouded, but this was evidently merely the effect of contrast, because he noticed not only Canopus, but several fainter stars, shining with undiminished brilliancy beneath the arch during the whole of the display. As the aurora progressed the arch gradually rose in the heavens. At 8 p.m. the first bright streamers appeared, and were most numerous to the westward. Above and amongst the streamers were glowing patches of the most beautiful rose-colour. The aurora was now a magnificent spectacle, its light being sufficient to render all the leading features of the landscape clearly discernible, and large print could be read with little difficulty. Shortly before 9 p.m. the dull light of the moon could be seen in the

east-north-east. At this time what appeared to be the beginning of a second arch formed above the original one. It formed with great rapidity in the south-west, extending itself in an easterly direction for a short distance, and then vanished. The moon rose at 9 p.m., but did not appear to have much effect on the brilliancy of the display, until about 9.45 p.m., when the aurora was reduced to an arch of milky haze across the southern sky. Shortly after 10 p.m. there was a second display of streamers, which shot upwards as far as the zenith, where they dissipated in the most brilliant rosy glow. During this last display the arch appeared to become completely disintegrated, and at 10.30 p.m. scarcely a trace of the aurora could be seen. In view of the connection which he understood was generally supposed to exist between auroral displays and sun-spots, he looked at the sun the following morning with a telescope of moderate power, and noticed seven spots, two of which were evidently of very large dimensions.

Sir James Hector said the auroral arcs were always at right angles to the magnetic meridian. This meridian, however, is always in motion, vibrating from east to west, but the extent of vibration is much greater during an auroral display, as he had observed during his observatory-work in high latitudes in North America in 1857. In New Zealand the auroral rays converge to N.N.E. of the zenith, and form a crown at 80° altitude from the horizon. As a rule there is disturbance of telegraphic communication coincident with such discharges, so that it must be a terrestrial magnetic as well as an atmospheric electric phenomenon. The height of the discharge has been variously related from as low as house-tops to as high as 1,000 miles; but from fifty to one hundred miles is the result of the most reliable observations. With regard to the connection between auroras and solar storms, the few observations so far indicate that the influence is real, and that the action is almost instantaneous, even exceeding the velocity of light. It resembles a sympathetic action like the "Hertz waves" of radiant electricity traversing the ether. During the last twenty-five years, while he had been in charge of the records, there had been sixty-three auroral displays, of which fifty-two were visible only in the south of New Zealand. Of the eleven seen all over New Zealand, five were simultaneously recorded in Australia and at the Cape of Good Hope. In fourteen of these years none were recorded in New Zealand. The maximum records were twenty-one auroras in 1871 and sixteen in 1870. The other records vary from one to three in each year, except in 1882, when two displays—one in April and the other in November—each lasted over four days; but in this case some other cause may have been at work. During the same period of observations, as far as available, the relative area of sun-spots according to the best authorities has been,—

Year.	Area.	Year.	Area.
1868	8	1874	43
1869	36	1875	18
1870	78	1876	11
1871	113	1877	11
1872	99	1878	3
1873	67	1879	7

The year 1884 was a marked maximum for the number of spots, and so also was 1894. The probable recurrent sun-spot maximum period is considered to be twenty-two years, which seems to be borne out by general experience, so that this last interval of only ten years appears to be exceptional.

Mr. McLeod said we were greatly indebted to Sir James Hector for his valuable and interesting remarks, and especially for his explanation of Hertz's experiments, and the conclusions he (Sir James Hector) had drawn from them in connection with auroras. The telegraph system was

greatly disturbed during the last aurora, and on one occasion the instruments worked without the batteries while an aurora was taking place.

Mr. Maskell said one practical point not referred to is whether the climate is affected by these disturbances. In Canterbury, in 1870 and 1882, after auroras, the summers were much wetter than usual. In 1867–68–69 the summers were so dry that the crops were ruined, and we had no auroras. In fact, wet weather generally follows auroras. It is possible that the electrical disturbances may have an effect on the climate, and it would be worth while to take notice of this.

Sir Walter Buller said that in 1857 he saw an aurora in the Wairarapa. It was of a most brilliant crimson colour. He sent a description of it to the *Independent*, and would look it up.

Mr. Hulke said that in the Northern Hemisphere it is sometimes so red as to resemble fire. Now that we have telegraphic communication we can connect the appearance of sun-spots with auroras. He described how, with a simple telescope, sun-spots could easily be observed.

Mr. Hudson, in reply, said he was glad his short notes had been the means of getting so much interesting information from Sir James Hector.

Sir James Hector, in reply, said that sun-spots had been associated with the growing of wheat, so that if auroras are affected by sun-spots they must also affect the climate. He had also observed an aurora in the Rocky Mountains in America in 1857. He thought it was better to give any information he possessed on the same night as Mr. Hudson read his notes, so that all the facts should be together.

2. Ornithological Notes, by Sir W. L. Buller: (1.) On *Phalacrocorax colensoi*, of the Auckland Islands, and *P. onslowi*, of the Chatham Islands. (2.) *Œstrelata neglecta*. (*Transactions*, pp. 129, 132.)

Exhibits:

Sir Walter Buller exhibited a newly-hatched tuatara lizard (*Sphenodon punctatum*) which he had received from Captain Fairchild. He had been for years trying to obtain this young form for the British Museum, and, being of extreme rarity, he thought it would be interesting to exhibit it here before sending it Home. He explained that, some eggs of the tuatara having been taken into the lighthouse-keeper's house on Stephen's Island, the heat of the room hatched them out. The specimen exhibited, being one of these, was about a week old when placed in the bottle of spirits.

Sir W. Buller exhibited, and made remarks on, Mr. Salvini's new petrel from the Kermadec Islands (*Œstrelata nigripennis*). The bird is very similar to *Œ. cookii*, with which it had hitherto been confounded.

Mr. Maskell would like to know what Sir Walter Buller intended doing with the other three young tuataras. He thought it would have been better had Sir W. Buller given his first specimen to the Colonial Museum, and after that considered the Home museums. He thought we should have the first of everything in our own collections. The captain of the Government steamer should have first supplied the Government museum before he disposed of any to private collectors. Since the late storm two strange birds had appeared in our harbour: one a sort of gannet, and the other with long tail and wings. They were beautiful birds, and seemed quite tame. Could Sir W. Buller tell us what they are, and where they come from?

Mr. Tanner had also observed these birds, and would be glad to hear something about them.

Sir James Hector did not think the young of the tuatara was so scarce as was supposed. Professor Thomas, of Auckland, had obtained some eggs, and had hatched them out. He would be very glad to get one for the Museum. It would be interesting to ascertain the condition of the obsolete eye in this lizard in the early stage of its existence.

Sir Walter Buller, in reply, said he recognized the first claim of the local institutions, but in some cases it was better to send objects Home to specialists, who had better opportunities of working them out. In this country we are often placed at a great disadvantage through not having the necessary books of reference and collections for comparison. He acknowledged and admired the industry with which Sir J. Hector and other workers applied themselves to original research, but as a rule there was too much material for the limited number of workers. Take, for example, the case of the adult tuatara. We had been collecting and studying this lizard for years; but it remained for Professor Moseley, of Oxford, to make the extraordinary discovery of its possessing a third and obsolete eye at the top of its head. The birds referred to by Mr. Maskell were the gannet (*Dysporus serrator*), very similar to the English species, but easily distinguished by the black feathers in the tail; and the common tern, or sea-swallow (*Sterna frontalis*). Their appearance in the harbour was due to the long-continued storms on the coast, where both are very plentiful. He mentioned several breeding-places where they are met in countless numbers. Mr. Maskell had expressed a hope that they would remain with us, as their evolutions on the wing were most interesting to watch; but this was quite impossible. They would disappear with a change of weather as suddenly as they had come. As he happened to have another young tuatara hatched out at the same time, he would send that to the British Museum, and present the specimen now on the table to Sir James Hector for the Colonial Museum.

A large and handsome collection of insects lately deposited in the Museum were exhibited. It had been made and arranged by Mr. Norris.

Mr. Hudson said this was a very fine collection, and Mr. Norris deserved much praise for his great industry. There were several valuable specimens in the collection, especially the glow-worms, the large green moth, &c., and the examples illustrating the life-history of white and black moths. Until more interest is taken in science in New Zealand, collectors will be disposed to send their collections to England and other places where they will attract more attention.

Sir James Hector said he would like to get a list of the fine collection now exhibited, with a view to publication; and Mr. Norris promised to supply this. All the specimens had been obtained in the neighbourhood of Tinakori Road and the Botanic Gardens.

Eighth Meeting: *9th September, 1894.*

Major-General Schaw, President, in the chair.

Before the meeting commenced, Sir James Hector, on behalf of the members, congratulated General Schaw on his return to the chair after his long illness; and General Schaw thanked those present for their kind expressions.

The President, before proceeding with the ordinary business of the meeting, read an extract from an article in the *Royal Engineer*

Journal of the 1st August, 1894, as follows: "A most remarkable and valuable calculation has been achieved by a competent, unprejudiced, and distinguished investigator as to the accuracy of Major-General Drayson's discovery, described in previous issues of the *Journal*. Admiral De Horsey took the recorded positions of a star, found by observation at various dates, and calculated by geometry the position of the pole of second rotation, the annual movement of the pole of the heavens, the position of the pole of the ecliptic, the decrease in the obliquity at various dates, the period during which an entire revolution of the equinoxes would occur, the amount of extension of the arctic circle during this revolution, and other items of very great importance. The results obtained by this original process differ only $\frac{1}{3}$rd of a minute of arc in two cases, and only $\frac{1}{100}$th of a second and $\frac{1}{100}$th of a second in other cases, from the results given by Major-General Drayson." The President observed that, so far as he was aware, this was the only real criticism of Major-General Drayson's discovery which had yet been made, and it was gratifying to learn that this searching mathematical criticism so perfectly confirmed the discovery, and its astronomical and geological consequences, which he had the honour of bringing to the notice of the Society.

New Member.—Mr. Percy E. Baldwin.

Papers.—1. "Myths of Observation," by E. Tregear, F.R.G.S. (*Transactions*, p. 579.)

Sir James Hector thought the paper very interesting, and deserving of thoughtful consideration. At the same time we must be careful, in interpreting such traditional myths, not to strain observed facts. Evidences of former great changes wrought by ice, water, and fire are found in all parts of the world; but there is no evidence that the action of these agencies was simultaneously exercised over distant areas. Even during the last year we have had evidence of local deluges and local fires, local volcanic outbursts, and local excesses of cold, all of which might have originated myths among savages; but these would not universally apply, although they might spread even among nations that had not experienced the phenomena that gave rise to them, nor is there any proof that the similar myths referred to the same events, or to universal catastrophes. He also protested against mixing up widely-distant geological epochs, such as the extension of a Cretaceous and Miocene temperate flora into the arctic circle, with the Pliocene glacial extinction of the mammoth and the origin of myths in the human period, these having been events separated by vast periods of time.

Mr. Maskell said it was difficult to discuss a large question like this without carefully reading the paper; but he had very little sympathy with what Mr. Tregear had said. We should think more of facts than of theories. He should not like to see this paper in the Transactions, because it is not original; everybody has read it over and over again, and the deductions have all been given in various works. Professor Sayce was called by Mr. Tregear "the champion of orthodoxy," and it is unfortunate that such sneering allusions should be made in a professedly scientific paper.

General Schaw said that, as Mr. Tregear had alluded to the mammoths preserved in foreign mud in Siberia, as indicating a more sudden change of climate than would have resulted from the second rotation of the earth described in his (the President's) inaugural address, he felt called upon to make some observations on the subject. It must be noted that an increased obliquity of the axis of the earth's diurnal rotation to the plane of the ecliptic would not only have caused an arctic winter to extend further towards the equator, but also would have increased the

summer temperature in those latitudes. This would doubtless have caused great annual migrations of such animals as the mammoth, which would have found their feeding-grounds nearer the poles in the summer, and would have been obliged to travel away from the poles in the winter. We may well imagine that irregularities in the seasons would have been even more marked during the glacial period than they are now, and that herds of migrating animals might be overtaken and destroyed by a sudden setting-in of winter, or by great floods caused by melting snow in summer and autumn. Darwin, in his Voyage of the "Beagle," mentions the destruction of great numbers of animals overtaken by an early setting-in of winter on the eastern slopes of the Andes when migrating towards the pampas, their winter habitat. Some such vicissitude may probably account for the frozen mammoths now found in Siberia. We know that within the arctic circle the ground is now frozen so deeply during winter that only the surface is thawed during the short summer, and yet this surface supports vegetation. Animals may have been overwhelmed by and buried in floods of liquid mud during the glacial age, and so deeply embedded that the mass would have been frozen up and preserved until a river, cutting through the deposit, exposed the entombed animals in the river-banks, where they are now found.

Mr. Tregear was sorry his paper had provoked such bitter comment. The paper, he considered, was as original as most papers of the kind are. He disclaimed any intention of annoying any one, and especially any desire to sneer at Professor Sayce. Sir James Hector had the right to discredit myths, but he must surely allow that myths are valuable in imparting a knowledge of history, and if the subject is worthy of human thought it is worth bringing before the Society.

2. "Some Curiosities of Bird-life," by Sir W. L. Buller, K.C.M.G., D.Sc., F.R.S. (*Transactions*, p. 134.)

3. "On the Wetas, a Group of Orthopterous Insects inhabiting New Zealand: with Descriptions of Two New Species," by Sir W. L. Buller. (*Transactions*, p. 143.)

Mr. Travers said, in regard to Sir W. Buller's remarks about the injury done to the native birds, &c., by the introduction of polecats, stoats, and weasels, it was not so much the fault of the Government—they were introduced as the natural enemy of the rabbit, and no doubt it was a mistake to bring them here. The ferret is not so dangerous, and is really not much objected to, but the destructive habits of the stoat and weasel are well known. They have left the districts where rabbits abound for places where they can get the birds and birds' eggs. In Nelson they did considerable damage. With regard to the weta, there was one that he did not see among the collection on the table: he had obtained one himself, and the antennæ were 11in. long, and this was, perhaps, because their sight was so defective.

Mr. Harding agreed with what the author said regarding stoats and weasels. He had seen in Mr. Colenso's collection a much larger weta than any now exhibited. He did not think they were quite harmless.

Sir W. Buller, in reply, said he agreed with Mr. Travers that the remarkably long and sensitive antennæ possessed by the different species of *Macropathus*, all of which, so far as he was aware, inhabit caves, were specially useful as feelers to those dwellers in the dark. He had carefully examined the specimens, and, although the visual organs were, perhaps, imperfect, it could not be said that those wetas were blind, as is undoubtedly the case with some other cave insects. The eyes, however, have a very different appearance from those of the tree-wetas, *Deinacrida* and *Hemideina*. There are probably other species not yet described—for example, the alpine form exhibited by Mr. Hudson that evening, and

another much smaller one in his son's collection; and it seemed to him that this was just one of those groups which ought to be worked out on the spot. It was an endemic group of Orthoptera, being entirely restricted to New Zealand, and did not therefore call for comparison with forms inhabiting other countries and not readily accessible to collectors here. It was, of course, possible that we might make mistakes in discriminating new genera and species; but, on the other hand, specimens sent to our great centres of learning did not always receive the attention we looked for. He might mention that in 1886 he found in a cave at Rotorua a beautifully-banded species of *Macropathus*, which he believed to be new. He took to England with him a bottle full of specimens in spirits, and sent them to one of the museums, where there was a specialist for such work, hoping to have the species named and described. But to this day, so far as he could learn, the stopper had remained in the bottle, and he would probably have to investigate the subject for himself on his next visit to Europe.

Sir James Hector exhibited some fine specimens of British and New Zealand birds, mounted by Mr. Yuill; and Mr. Hudson exhibited specimens of the weta to compare with those submitted by Sir W. Buller.

NINTH MEETING: *17th October, 1894.*

Major-General Schaw, President, in the chair.

Papers.—1. "On some Peculiar Cases of the Reflection of Light," by Major-General Schaw, C.B., R.E. (*Transactions*, p. 535.)

2. "On a Peculiar Appearance in a Cloud during the Daylight," by A. J. Lichfield.

ABSTRACT.

The author described an iridescent cloud from which the spectrum rays were diffused, and not arranged as in a rainbow. The sky was clear, with passing clouds, but no other cloud presented the same phenomenon.

Sir J. Hector considered the President's paper most interesting; and such accurate observations were of great use. With regard to the light in the cloud, it might have been caused by ice, it might have been an electrified cloud discharging hail, or it was possibly due to smoke in the atmosphere from a bush fire.

Mr. Tregear had observed similar lights in clouds, but could not account for it.

The President thought it must have been produced by ice, and that it was a portion of a halo formed where a frozen cloud was in the position required to produce the effect.

3. "A Synoptical List of Coccids reported from Australasia and the Pacific Islands up to December, 1894," by W. M. Maskell. (*Transactions*, p. 1.)

The author read extracts from the paper, and made some remarks upon the manner in which new species were made. He said that the majority of scientific workers were more anxious to have their names attached to specimens than to apply themselves to any real work of the

study itself; the very slightest variation seemed sufficient to induce them to make a new species. But with the Coccids they had been careful in this respect, and hence the few new species: they required an organic character, and not a mere colour. It was a question as to how far we were warranted in making long lists of species on small, trivial, and external characters.

Mr. Hudson was sorry Sir W. Buller was not present, as he would more fully answer Mr. Maskell on this subject. What applied to Coccids did not apply to other insects; each case should be judged on its merits. If colour and other characters are constant, then we must accept them as sufficient.

Sir J. Hector said that Mr. Maskell's list would be most valuable, as it would contain all the known species of Coccids up to date, with remarks and information that will be most useful to farmers and fruit-growers.

The President also said the list would be of the greatest use.

4. "On Baryte: a Rare Form," by Sir J. Hector.

This specimen was handed to Sir J. Hector by Major-General Schaw. It is a nodular variety, known as "Bologna stone," and is composed of sulphate of baryta, or heavy spar. It commonly occurs in differently-formed crystals, and is used as a substitute for white-lead, and also in sugar-refining. This particular form is remarkable for its brilliant phosphorescence after heating with charcoal. Bologna phosphorus was made by powdering this material and cementing the powder with gum. The locality is the glauconitic marls, inland of Akiteo.

5. "Pélé's Hair (Volcanic Glass-fibre)," by Sir J. Hector.

The sample exhibited by Sir J. Hector was forwarded by the Customs Department, and was taken from a box that was cast up on the north-west side of Portland Island. The box was found by Mr. C. H. O. Robson, the lighthouse-keeper, on the 9th September. It was strongly made of 2in. pitch-pine boards, without any marks. It contained a mass of the fibrous variety of volcanic glass known as Pélé's hair, packed in charcoal, in which were a charred cotton-reel and fragments of bamboo.

Pélé is the Hawaiian name for the goddess that presides over Kilauea, the great volcano of the Sandwich Islands. The hair is formed by the action of the wind on the jets of very fluid lava or volcanic glass, which it blows to leeward in delicate films, each weighted by a little spherical globule of the glass. The films accumulate to leeward of the pool in great masses, like mown grass, and lie all pointing in the same direction.

6. "On the Occurrence of a Mineral Belt in the Heart of the great Schist-formation of Otago," by Sir J. Hector.

The author exhibited a large series of specimens of serpentine, asbestos, and other magnesian rocks from the south end

of the Crefell Range, west of Cromwell, to prove the existence of intrusive rocks in that locality.

7. "On the Growth of Ferns; and on a New Fern (*Lygodium*), now first reported," by H. C. Field. (*Transactions*, p. 446.)

Mr. Tanner wished to know if the fern referred to was edible.

Mr. Field replied that it was not.

Mr. T. Kirk did not think the fern new, and until further evidence is received we should not accept it: it is not even allied to the plant named. The variation in growth is interesting, but it is nothing new.

The following specimens were exhibited: (1.) Seven birds, chiefly petrels, presented to the Museum by Captain Fairchild, and mounted by Mr. Yuill. (2.) Minerals from Stewart Island and West Coast, by Mr. F. Walter. (3.) Maori adze, found in a drain in Willis Street, Wellington, by Mr. Mestayer, C.E.

Tenth Meeting: *14th November, 1894.*

Major-General Schaw, President, in the chair.

New Member.—Dr. Anson.

Papers.—1. "Further Coccid Notes: with Descriptions of New Species from New Zealand, Australia, Sandwich Islands, and elsewhere, and Remarks upon many Species already reported," by W. M. Maskell. (*Transactions*, p. 36.)

2. "On the so-called Vegetable Caterpillar and other Fungi that attack Insects," by W. M. Maskell.

Abstract.

Insects were much subject to attacks from many kinds of parasites, which might be either animal or vegetable. On the present occasion he confined himself to the vegetable parasites, which are all, or almost all, of the great class of Fungi. And these Fungi which prey upon insects are usually divided in the present day into five groups, of which the first includes the Bacteria; the second an obscure and peculiar family named Laboulbeniaceæ; the third a number of "moulds," of which the silk-worm disease is one; the fourth the family of Entomophthoreæ; and the fifth some "ascigerous" fungi, including one so-called "vegetable caterpillar." He proposed to deal now only with the fourth and fifth of these groups, and proceeded to explain the mode of growth of some of them, illustrating his remarks with specimens in the natural state, specimens mounted and exhibited on a number of microscopes, and diagrams on the black-board. These specimens and diagrams included the common "house-fly fungus" (*Entomophthora muscæ*), and various fungi which, in the New Zealand forests, attack homopterous insects. Individuals of the genera *Ctenochiton* and *Lecanium* (Coccids), and *Rhinocola* (Psyllid), were shown infested with fungus, and the action of the parasite was explained. It was stated that in these last cases the fungi varied a good deal, though their action as regards the insects seemed the same. They took possession of the whole interior of the body, and, when at the ripen-

ing or fructifying stage, protruded through the skin in order to scatter their spores: a similar proceeding also characterizing *Entomophthora muscæ*. Passing afterwards to the "vegetable caterpillar," the speaker showed that the name was very appropriate, as the thing was partly caterpillar and partly fungus, although some writers (notably Mr. Pratt, in his "Travels in China and Thibet") spoke of it as "a plant which imitates a caterpillar." The grub itself was stated to be the larva of some large moth, probably of the genus *Hepialus:* and the fungus belonged to the genus *Cordyceps*, the specific name being *C. robertsii*. Here the action of the fungus on the insect was, practically, the same as that of *Entomophthora*, as it took possession of and destroyed all the interior organs; but, as the caterpillar was subterranean, the fungus, in order to reach the air and scatter its spores, pushed out a long stem through the earth, and at the extremity of this stem the "asci," or small bags containing the spores, were developed. Specimens of the caterpillar and of the *Cordyceps* were exhibited both in the natural state and under the microscope. The speaker concluded by expressing the hope that some of our young colonial students would take up the investigation of these insect parasites, which, over and above their scientific interest, had a very great economical value, inasmuch as they tended to decrease the enemies of the cultivator.

Mr. Hudson considered this a most interesting paper. The fly fungus referred to is found chiefly in autumn. It is a matter of opinion as to whether flies are injurious; they certainly are good scavengers, and it is a question whether they ought to be destroyed. There was not sufficient evidence to show that Mr. Pratt was wrong in his opinion as to the vegetable caterpillar. It is important to ascertain for certain what insect it would turn out to be if not attacked by the fungus. The larva of the *Porina mairi* was the only one large enough, and they were very rare, probably owing to the fact that they are so frequently attacked by *Cordyceps robertsii*. Of course it may be *Hepialus virescens*. If we could get the caterpillar free from the fungus we could ascertain what it was.

Sir James Hector considered the author had done great service by his interesting paper, and had opened a new field for preventive natural history by the discovery of fungi antagonistic to insect blights. The phenomena of the fly and of the caterpillar he considered very different. In the case of the first the perfect insect was destroyed; but in the case of the caterpillars the spores of the fungus were probably passed on by the perfect moth through the egg and grub, as in the case of the pebrene of the silkworm, the investigation of which was one of Pasteur's greatest researches.

Sir W. Buller said it would require a brave man to break a lance with Mr. Maskell on a field of which he was an acknowledged master, and he would therefore not attempt to criticize the part of his paper relating to scale-insects and fly-killing fungi. But he ventured to challenge Mr. Maskell's description of the vegetable caterpillar (*Cordyceps robertsii*), because he considered it unscientific and misleading. Mr. Maskell had described this natural object as a sort of compound caterpillar or animal at one end and fungus or vegetable at the other. He (the speaker) contended that, so far from this being the case, it was *Cordyceps*, or vegetable, from one end to the other. There had, of course, originally been a living caterpillar, of which the fungus-growth was an exact replica, but what he now held in his hand was in its entire tissue and substance, even to the covering cuticle, pure vegetable. The spores of the fungus, taken into the body of the caterpillar, which had gone underground for the purpose of undergoing its natural transformation, had germinated, and, rapidly filling the body, had absorbed or assimilated the whole of the animal substance, its growth or development being circumscribed by the outer integument or skin of the caterpillar, which it had only pierced at

one point—at the neck, for the purpose of sending up a shoot. Sir Joseph Hooker's theory was that the minute spores got lodged in the folds of the skin on the caterpillar's neck in the progress downwards, which appears to be always tail-first. Mr. Maskell had probably never examined any but hard and dry specimens like that now exhibited, but he himself had dug up hundreds of them. In the fresh state the body of the so-called vegetable caterpillar is a compact vegetable substance with a round passage or open canal down the centre. It has a fragrant woody smell, and to the taste is exactly like Barcelona nut. What had originally been the skin of the animal caterpillar had rotted off, and the outer brown skin on the specimen exhibited was the natural covering of the fungus—an extremely thin layer that could be scraped off with a knife, disclosing the white pulpy substance underneath. The Maoris, who make use of certain woods and vegetable products for procuring their tattooing powder, have discovered a valuable property of the vegetable caterpillar; for, reducing it by burning to a cinder, they crush it into a fine powder, and obtain a black pigment for their ornamental *moko*, rubbing it into the cuts on the skin. He agreed with Mr. Hudson that the caterpillar attacked by *Cordyceps robertsii* was not the larva of *Hepialus virescens*, as was generally supposed. Whether it was that of *Porina mairi* (Buller), as suggested by that gentleman, he could not say, but he thought it was quite possible. The only specimen of *Porina mairi* at present known was found by him in the Ruahine Ranges in a locality where the vegetable caterpillar was very abundant. The moth is supposed to be very rare, but that might be because it had not been properly looked for, and it certainly belongs to a group whose habits are strictly nocturnal. He had collected them in all suitable localities in the ranges, and had very seldom found them under those particular trees. They invariably have a single stem, with its fructification at the top and well out of the ground; but sometimes the fungus bifurcates less than an inch from the head, producing two stems. The body of the caterpillar is sometimes slightly curved or twisted, but in all his experience he had never known a specimen exhibiting the stem-growth from any other part of the body. He might here mention that there is an erroneous figure of the vegetable caterpillar in Mr. Edward Wakefield's "New Zealand after Forty Years" (p. 82). There the caterpillar is represented as lying horizontally, with the stems growing upwards at a right angle with the body. That never occurs in nature, and he supposed that Mr. Wakefield had been misled by having a damaged specimen with the stem detached.

Mr. Travers said he had found the fungi at the roots of birch-trees. He had found the beetle mentioned by Mr. Maskell, and it presented the appearance of the vegetable caterpillar. He differed from Sir Walter Buller regarding the vegetable caterpillar, and agreed with Mr. Maskell.

Mr. T. W. Kirk said that the white grub referred to had been tried here, but without success; perhaps it is not the right species. He had specimens of the *Hepialus*, and was quite sure that they do take to the ground. The stems grow from either end, and from both ends of the single specimen. The insect is not dead until it is quite taken up by the fungi.

Mr. T. Kirk said that Mr. Maskell, in his interesting remarks on the "fly fungus" (*Saprolegnea ferox*), had omitted mention of the most important fact connected with it—namely, its identity with the fungus that attacks fresh-water fish in various countries. Ten or twelve years ago it committed great ravages amongst the trout in the Otago lakes, numbers being diseased and unfit for human food. It was supposed that flies infested with the fungus in its rudimentary stage were swallowed by the fish, when the mycelium speedily developed, until it permeated its muscles and formed white patches on the external surface, the fin being often found completely rotten from the effects of the parasite. Vast

numbers of spores would also be discharged in the water, and would germinate whenever they came in contact with healthy fish, so that an immense amount of injury had resulted from an apparently insignificant cause. He had paid considerable attention to the fungi infecting certain Coccidæ, but had never succeeded in obtaining perithecia; it was, however, clear that more than one species was to be found, although hitherto nothing had been done in the way of identification. He could not accept Mr. Maskell's opinion that the vegetable caterpillar of New Zealand (*Cordyceps robertsii*) had been found in other countries, but believed it to be endemic. The Cordyceps which attacked the larvæ of Cicada was a smaller species, much-branched, and of a pale-red tint. A Chinese species (*C. sinensis*) occurs in such large quantities as to form an article of food. It is tied up in small bunches and sold in the markets. Perhaps the most striking of the fungi growing on large caterpillars is the *Cordyceps taylori* of Australia, a rare species, with several flattened branches, resembling a miniature stag's horn: it is a prince amongst its congeners. He had seen other kinds of fungi attacking the larvæ of beetles, and obtained a large moth infested by a *Sphæria*, which had filled the abdominal cavity with mycelium, and produced a double or triple row of stipulate perithecia along the entire extent of the abdomen. Mr. Maskell had drawn attention in an interesting manner to a neglected group of curious organisms. He would like to add, with regard to Mr. Maskell's complaint concerning the small amount of attention paid to the study of microscopic plants and animals by the younger members of the community, that a decided impetus would be given to work of this kind by the reintroduction of biology into the course of study at Wellington College. That institution was furnished with good microscopes and a considerable amount of accessory apparatus, as well as with collections of plants, minerals, &c., all of which had been lying idle since the College had ceased to be affiliated with the New Zealand University.

Mr. Maskell replied briefly to the remarks made, and, in answer to Sir W. Buller, said that, after all, the objection raised by that gentleman was only a splitting of hairs. The thing, for at any rate ninety-nine hundredths of its life, was a caterpillar attacked by a fungus, just as the fly on the window-pane was a fly which the fungus had killed. To say that when it was dried up and rotten there was then no caterpillar left, seemed to be simply a piece of dialectic distinction, which would have been more valuable if Sir W. Buller had been accustomed to microscopic investigations. He had himself clearly seen the skin of the caterpillar, even in an old specimen, and it appeared to him quite certain that, if that skin was destroyed by a fungus, that fungus was not *Cordyceps*, but some form of mould. The question raised by Sir W. Buller had absolutely no economic importance, and at its best was an objection so fine-drawn as to be not even important in a scientific sense.

Mr. Maskell then exhibited specimens under the microscope.

ELEVENTH MEETING: *28th November, 1894.*

Mr. W. T. L. Travers in the chair.

It was announced that, in conformity with the Act, Major-General Schaw had been elected Governor of the New Zealand Institute to represent the incorporated societies for the year 1895.

Papers.—1. "Observations on some peculiar Maori Remains, with Remarks on the Ancient Institution of Tapu," by Sir W. L. Buller. (*Transactions*, p. 148.)

Sir J. Hector said that the specimen of the cranium exhibited was a very interesting one, and was thicker than usual. He thought, however, that the condition of the bone might be due in some measure to the deposit in which it had been preserved, and he would like to know what the nature of the deposit was. As to the Mallicolo skull, he was of opinion that the form was entirely due to artificial compression in youth. It was unlike the skulls of the flat-headed Indians, the effect there being produced by pressure during infancy by a board on the head. Instead of a board the Mallicolo may have used a swathe of cocoanut fibre. He had examined seventeen Mallicolo skulls in a collection at Sydney, and no less than seven of them presented the remarkable feature of a suture down the centre of the frontal bone. He exhibited a Maori skull, collected by himself at Parapara, in which this feature was present; but he had never met with another case among Maori skulls. No doubt artificial pressure had something to do with this.

Mr. Travers suggested that the abnormal position of the tooth in the Opotiki specimen might be due to a blow at some time.

Sir W. Buller, in reply, explained that the human remains on the Papaitonga Island were merely covered with rank vegetation, and had not been imbedded in any deposit. As to the frontal suture, he thought that feature was quite independent of the shape of the skull. It was admitted to be very rare. The Maori skull exhibiting it was a remarkably well-formed one, whilst in the Mallicolo skull now before the meeting there was not the slightest trace of a frontal dividing suture. He believed it was still a moot point with Sir James Paget, and others who had studied the subject, whether the form of the Mallicolo skull was natural or artificially produced. It had been argued that if pressure had been applied there would have been a bulging of the parietal bones; but, although there was practically no forehead, there was a certain amount of symmetry in the skull, which was produced backwards. There were several specimens in the Museum of the Royal College of Surgeons, and, so far as he could remember, only one of these presented the frontal suture. As to Mr. Travers's suggestion about the tooth, he thought it highly probable that the abnormal growth was originally caused by a blow or some other external injury. He had submitted the specimen to Mr. Rawson, the dentist, who said he had never met with a similar case in the whole of his experience.

2. "A Revision of the New Zealand Gentians," by T. Kirk. (*Transactions*, p. 330.)

3. "On the New Zealand Species of *Gunnera*, L.," by T. Kirk. (*Transactions*, p. 341.)

Sir James Hector said these were very valuable papers. The remarks regarding the gentians were most interesting. It was hardly safe, from our present knowledge, to give the exact localities where these plants are to be found. He thought he had seen them in the Kaimanawa Ranges as early as 1866.

Mr. Hudson said the remarks regarding the prevailing colour of the flowers being white in New Zealand were interesting. Insects seemed to be attracted by these white flowers.

Sir W. Buller asked whether Mr. Colenso had not explored the Kaimanawa Ranges.

Mr. Harding did not think this locality had been examined botanically.

Mr. Travers said he was quite familiar with these beautiful plants in Nelson. He had seen them in great profusion on the Hanmer Plains, and extending up the Clarence Hills as high as 4,000ft. It was almost impossible to cultivate them.

4. "On Oyster-culture in New Zealand," by Sir James Hector.

ABSTRACT.

The paper is a summary of investigations which are being made for Government. The oysters in New Zealand by their shells may be distinguished as many varieties, but are clearly divided into two groups by their habit of propagation. Outward form of shell goes for nothing as a distinguishing mark, except that heavy, dense shells without outward markings predominate in the south and in deeper waters; but occasional exceptions occur. The form of the shell is chiefly determined by the nature of the surface to which it is attached. Reproduction, which is the chief factor in the distribution of the oyster, is controlled by the temperature of the sea. In the north of New Zealand, where for a short season the temperature of the sea with inflowing tide reaches 70° Fahr., oysters which are not strictly hermaphrodite, but only seasonally so, have an advantage. As the tide flows, at the proper season the valves open, and the ova and milt of different individuals are together swept up the tidal creeks, there fertilize and develope, and, settling, cling to their final resting-place between tide-marks, where they grow a close-fitting shell that enables them to withstand the tidal periods of drought. The other extreme is controlled by the more rigorous conditions of Foveaux Strait, where the winter cold and the insufficient summer temperature of the sea prevent the survival of intertidal oysters, so that the oysters that survive are those in deep water, which do not shed the male and female elements of the spawn at different seasons but at the same time and within the shell, and there nurse the spawn until they complete the larval stage and acquire rudimentary shells. In this form they are discharged from the parent oyster in thousands, and after a very brief independent existence they assume a sedentary life. Between these, the extreme forms of habit, there are in New Zealand an almost unlimited variety, and even that must vary with the seasons. But this very variability affords a good opening for the oyster-cultivation; and for the development of oyster-culture as a great national industry New Zealand enjoys very prominent natural advantages.

Mr. Richardson said he was glad to hear that we are likely to have a good supply of oysters in New Zealand.

Mr. Travers said it was disastrous to draw altogether on the natural beds for supply, and dredging should not be allowed. Properly-supervised cultivation should be carried out, and inspection. Skill as well as capital was required in this industry. Many of our natural productions have, owing to the absence of proper supervision, been destroyed; and now, when almost too late, they are found to have been valuable.

5. "Further Contribution to a Knowledge of the Sponges of New Zealand," by H. B. Kirk, M.A. (*Transactions*, p. 287.)

Sir Walter Buller exhibited twelve specimens of the beautiful land-shell *Paryphanta hochstetteri*. Referring to Mr. Travers's proposed discrimination of two species—one distinguished by its black undersurface, whilst in the other it was yellow—he desired to point out that in the present series there was a perfect gradation of colour. One of those exhibited was from

Nelson, and in this the undersurface was of a uniform yellow colour; in another, from Manawatu, the undersurface was perfectly black; and between these two extreme forms the specimens now on the table exhibited almost every intermediate shade of colour. The size is not a criterion of specific value, for it is very variable, and evidently dependent on age. Some of those now exhibited were larger than the type figured by Hochstetter, whilst others were much smaller. One of those from Manawatu was quite as yellow on the undersurface as the example from Nelson. He concluded, therefore, that there was only one species of this form.

ANNUAL MEETING: *20th February, 1895.*

Major-General Schaw, President, in the chair.

New Members.—Mr. T. H. Hustwick, Dr. Ewart, and Mr. G. W. Wilson.

The annual report for 1894–95 was read and passed; also the balance-sheet, showing the receipts to be £169 11s. 3d. (including the balance carried forward, £57 4s. 3d.), the expenditure £114 9s. 9d., and the balance in hand £54 11s. 6d. There was also a sum of £24 1s. 6d. lodged in bank at interest, which increased the available balance to £78 13s. Seventeen new members have been added to the roll during the year, making a total now on the list of 150.

ELECTION OF OFFICERS FOR 1895.—*President*—Thomas Kirk, F.L.S.; *Vice-presidents*—W. T. L. Travers, F.L.S., R. C. Harding; *Council*—W. M. Maskell, G. V. Hudson, F.E.S., Sir James Hector, F.R.S., Edward Tregear, F.R.G.S., Major-General Schaw, C.B., R.E., Sir Walter L. Buller, F.R.S., H. Farquhar; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Papers.—1. "Note on the Vegetable Caterpillar (*Cordiceps robertsii*)," by Sir W. L. Buller. (*Transactions*, p. 155.)

2. "On a New Shell (*Anomia walteri*)," by Sir J. Hector. (*Transactions*, p. 292.)

3. "On the Utilization of Mineral Springs in New Zealand for the Production of Ornamental Objects in Stone," by C. Smith.

4. "Notes from the Chatham Islands," by Major Gascoyne; communicated by Sir W. L. Buller.

ABSTRACT.

The author recorded the occurrence at Waitangi of two specimens, which were cast up on the beach, of *Regalecus*—the skin of one being like

burnished silver, and that of the other exactly like *Regalecus pacificus*, described in Trans. N.Z. Inst., vol. x., p. 247, except in the colour, which was dull-drab generally, and resembled that of some Indian land-frogs. Also a splendid specimen of the Pacific variety of tunny was stranded alive on the beach. The fish was between 6ft. and 7ft. long, and very handsome in appearance. Unfortunately, during a short absence from the spot where it lay, a man found it and immediately chopped it to pieces, so that even the skeleton was spoilt for scientific use. Lately a species of torpedo was obtained and skinned, and cured with alum and salt. It only differed from *Torpedo fusca*—as depicted in Trans. N.Z. Inst., vol. xvi., p. 284—in that the margin of the disc in front of the eyes was perfectly straight across instead of convex, and they had no "nick" on each side of the head, as shown in the plate referred to. The extreme length is 3ft., and the greatest width 25·5in.

Sir Walter Buller stated that the head of an equally large tunny was obtained by him on the Manawatu Beach in 1862, and is now in the Colonial Museum.

5. "On a New Fern," by H. C. Field.

Mr. T. Kirk thought this only an abnormal form, and not a new fern.

6. "On some New Species of *Tipulæ* (Daddy-long-legs) found in New Zealand," by G. V. Hudson. (*Transactions*, p. 293.)

7. "Description of New Grasses from Macquarie Island," by T. Kirk. (*Transactions*, p. 353.)

8. "Descriptions of New or Remarkable Plants from the Upper Waimakariri," by T. Kirk. (*Transactions*, p. 349.)

9. "A Revision of the New Zealand Species of *Colobanthus*, Bartling," by T. Kirk. (*Transactions*, p. 354.)

10. "On some Living Colonial Rarities," by H. C. Field.

11. "On a Process for coating Non-conducting Substances with Metal," by H. N. McLeod.

Abstract.

Any article, and foliage, wet or dry, or even oily, may be treated, and there is practically no limit to the selection. The most delicate of columbines, and lizards, may be treated with equal ease. In fact, when the process becomes known all dabblers in electrolysis will take to producing articles by it. There have been produced in metal, specimens of insects, narcissus, camellias, violets, jonquils, snowdrops, grasses of the most delicate description, leaves (reproducing the veins with the greatest fidelity), fronds (having five hundred points to surface of 2in. square), designs on specimen glass, &c. By the process the articles are covered in a few minutes, after which the electroplating is finished in the ordinary way. No chemicals are used. In many cases where black-lead is now used the process will supersede the old method.

AUCKLAND INSTITUTE.

First Meeting: *4th June, 1894.*

Mr. J. H. Upton, President, in the chair.

The President delivered the anniversary address, taking as his subject "The History of Money."

The President said: In opening a new session of this branch of the work of the Institute, I cannot refrain from inviting you to allow your thoughts to dwell for one moment on the memory of our late President, Professor Pond. Mr. Pond took a warm interest in the progress of this Institute, and by his death we suffer a great loss. His sympathies were, however, not confined to this Institute, but were freely open to every movement for the welfare of the community. His gentle temper and his modest character endeared him to all who had the privilege of his friendship, while his lofty sense of duty and his great abilities marked him out for a career of the widest usefulness amongst us: his loss is one not easily to be repaired. He was ever anxious to do what he could for the general weal, and deeply earnest in the doing of what he undertook. But even when he entered upon what was to prove his last service to this Institute—namely, his year of office as President—already the Silent Shadow stood waiting, and, with all the bright possibilities of a brilliant career opening out before him,

"God's finger touched him, and he slept."

Second Meeting: *18th June, 1894.*

Mr. J. H. Upton, President, in the chair.

New Member.—Mr. F. G. Ewington.

Mr. E. Withy gave a popular lecture, illustrated by diagrams, on "The Economic Effects of Various Land-tenures."

Mr. Ewington spoke at some length, arguing that the private ownership of land was not the only cause of the existence of the unemployed classes. There always had been, and always would be, the careless and improvident; and, besides that, famine, fire, floods, changes of fashion, &c., might, and did, create unemployed people. He considered that Mr. Withy had overlooked many social and economic facts of the first order when dealing with his subject.

The President, in moving a vote of thanks, said that Mr. Withy must have forgotten that, if there were no unemployed in primitive times, there was slavery. Now, in civilized countries men were free, and with their freedom came additional responsibilities, one of them being the care of the poor.

Mr. Withy briefly replied.

Third Meeting: *2nd July, 1894.*

Mr. J. H. Upton, President, in the chair.

New Members.—J. Brown, A. H. Hosking, W. Philcox, Professor Tubbs.

The President said he had much pleasure in announcing that the Council had purchased the celebrated carved house at Maketu. Some years ago it was intimated to them by their esteemed member, Mr. F. D. Fenton, that this famous house could be purchased; but at that time there were difficulties in the way of money matters. A few weeks ago, however, Mr. Fenton obtained an offer of the house at a very reasonable price, and at once placed it before the Council. The Council decided to accept the offer, and asked Mr. Fenton and Mr. Cheeseman to proceed to Maketu to complete the purchase and obtain possession of the house. This had been done, and the carvings would arrive in Auckland during the week. He would now ask Mr. Cheeseman to give a description of the house.

Mr. Cheeseman said: The carved house, which, through the assistance of our friend Mr. Fenton, has just been purchased for the Auckland Museum, was the property of Te Pokiha Taranui, the leading chief of the Ngatipikiao Tribe, a section of the Arawa. Te Pokiha is better known to us by his European *sobriquet* of Major Fox, he having commanded a portion of the Arawa contingent during the chase after Te Kooti. The house stood at Maketu, about eighteen miles south of Tauranga, and was built about 1868. It belongs to the class of carved houses known as *pataka*, or storehouses. These are raised on legs, and have the whole of their carvings and other ornamentation on the outside, thus differing from the *runanga*, or meeting-houses, in which it is the interior which is carved and decorated. The house is without doubt the finest and most complete of its class in existence, as you will probably all admit when it is erected in Auckland. It is about 35ft. long by about 20ft. broad, and has a height of 15ft. to the crown of the roof. The sides and both ends are formed of upright totara slabs, boldly and elaborately carved, the carvings being mainly grotesque representations of the human figure. The ridge-boards are carved to represent a number of *ngarara*, or lizards, running along the roof, and the *maihi*, or gable-boards, have carvings of the mythological animal known as *manaia*—probably a kind of taniwha. In front of the house is a carved verandah, some 5ft. or 6ft. deep, and it is on the walls of this that the most elaborate carvings in the house are placed, many of the slabs representing well-known ancestors of the Ngatipikiao Tribe. For instance, a large carved figure over the doorway stands for Tama te Kapua, the captain of the "Arawa" canoe, which, it will be remembered, was finally beached at Maketu after its adventurous voyage from Hawaiki to New Zealand. The *tekoteko* on the roof above is Takenga, one of the descendants of Tama te Kapua, and a remote ancestor of Pokiha; another *tekoteko* is Awanui, a son of Takenga; and so on. In fact, the chief figures on the house are evidently intended to illustrate Pokiha's genealogy. The house itself bears two names—one being Tuhua Katoore, the signification of which is "the pit of the taniwha"; the other Puawai o te Arawa, or "the flower of the Arawa." Maketu also possesses two runanga houses—one of them, known as Houmatawhiti, being the finest of its kind in New Zealand. As already mentioned, Maketu is noted as being the landing-place of the famed Arawa canoe; and a clump of mingimingi trees, old and hoary, and evidently of great antiquity, is still pointed out as having sprung from the skids which were used in hauling up the canoe on the beach.

On the motion of the President, a cordial vote of thanks was unani-

mously awarded to Mr. Fenton for his action in securing so valuable a relic of the Maori race for the City of Auckland.

Paper.—"The Geology, Resources, and Future Prospects of the Thames Goldfields," by James Park, F.G.S., Lecturer of the School of Mines, Thames. In the absence of the author, the paper was read by Professor Thomas.

FOURTH MEETING: *16th July, 1894.*

Mr. J. H. Upton, President, in the chair.

Professor Arnold Tubbs gave a popular lecture on Greek Art, entitled "A Greek Madonna."

FIFTH MEETING: *6th August, 1894.*

Mr. J. H. Upton, President, in the chair.

New Member.—Mr. G. Wilson, Inspector of Mines, Thames.

Paper.—"The Treatment of Lunatics, historically considered," by F. G. Ewington, Official Visitor to the Auckland Asylum.

ABSTRACT.

The lecturer considered that mind was one of man's best endowments. It made us heirs of the ages; enabled us to live the past over again, and anticipate the future; also to move amongst buried cities and extinct civilizations, and almost feel the heart-beat of our ancestors. The light of reason enabled Newton to deduce the law of gravitation from a falling apple; Galileo to infer from the sympathy between two magnetic needles that men at great distances apart might converse together; Edison to treasure up the human voice in the phonograph; Darwin to conceive and expound his marvellous theory of the origin of species; and Aristotle and Shakespeare, and other immortal leaders of thought, to sway empires vaster and more glorious than ever fell to the lot of political rulers. The lecturer then showed how necessary it was to realise the greatness of mind, in order to realise the seriousness of its ruins. He gave instances of patients under illusional and delusional insanity, also of some suffering from mania and idiocy. The lecturer next proceeded to show the necessity for public vigilance, and then emphasized the fact that the lot of the insane to-day might be any man's to-morrow, through fright, joy, grief, or a break-down in running the pace that kills in modern industrial life. After dwelling on the value of hope, the lecturer showed that in ancient times Hippocrates and others held very humane and scientific opinions on insanity and its proper treatment. Some illustrations were then given of cruelty practised in the Middle Ages, when lunatics were burned as witches or killed as demoniacs. Thence the lecturer proceeded to modern times, and showed how shamefully patients were bound, flogged, chained, caged, held up for public exhibition half drowned in surprise baths, chained in stalls, nearly

killed in rotating swings, left from Saturday till Monday in chains unattended, and otherwise ill-used. Mr. Ewington warmly eulogized Dr. Conolly, father of Mr. Justice Conolly, a celebrated lunacy reformer, and showed a portrait of him on the screen, and described a magnificent trophy given to him by the public in 1852 for ameliorating the condition of the insane. He also spoke of Gardner, Hill, and Churchworth as reformers in the same cause. Mr. Ewington pointed out that mechanical restraints are still used in 219 asylums, and assured his audience that the only safety was in good doctors and attendants, efficient official visitation, and a free Press. He spoke warmly in praise of Dr. Macgregor and the Auckland staff, and assured his audience that the insane were better cared for than they could be in their own homes. The lecturer next disposed of various misconceptions: (1) That attendants are less kind than relatives; (2) that lunatics are unkind to each other; (3) that lunatics are not sensitive; (4) that they are fools; (5) that all lunatics are dangerous; (6) that the asylum is not the best place; (7) that lunatics are always cutting capers; (8) that it is no good for friends to visit them. Mr. Ewington, in conclusion, dealt with the following needful reforms: Legal assistance at first examinations; better provision for classification; single rooms required, for which (in Auckland) £3,000 had been voted; convalescent homes; and lastly, funds should be given to needy discharged patients.

At the conclusion of the lecture a warm vote of thanks was accorded to Mr. Ewington.

Sixth Meeting: *20th August, 1894.*

Professor F. D. Brown, Vice-president, in the chair.

The Rev. J. Bates gave a popular lecture on "Comparative Religion."

Professor Brown, in moving a vote of thanks to Mr. Bates, said that he was glad to find a clergyman of the Church of England reading a paper like this. No one could read modern literature without feeling that persons who thought were dissatisfied with religion as it was now. Many ministers of religion were unwilling to recognize this fact. But it was the case that those who thought were straying away, perhaps, in the direction of the East. Darwin and Tyndall had had their say, and were gone, and the materialistic ideas of a few years ago, which were then thought so complete, were weakening. People were being attracted to the East in search of ideas that might revivify religion. Those of the clergy who recognized this were endeavouring to bring religion into line with modern thought.

Seventh Meeting: *3rd September, 1894.*

Mr. J. H. Upton, President, in the chair.

New Members. — Professor Egerton, M.A., D. Petrie, F.L.S., Mrs. D. B. Thornton.

Papers.—1. "Poetry considered as an Interpretation of Life," by Professor Egerton.

2. "A Yorkshire Blood-feud," by F. D. Fenton.

EIGHTH MEETING: *17th September, 1894.*

Mr. J. H. Upton, President, in the chair.

Professor A. P. Thomas, F.L.S., gave a popular lecture entitled "Darwin."

NINTH MEETING: *1st October, 1894.*

Mr. J. H. Upton, President, in the chair.

Papers.—1. "Shooting Stars and Meteors," by Professor H. W. Segar.

2. "Maori Preserved Heads," by the Rev. P. Walsh. (*Transactions*, p. 610.)

3. "The most frequent Pelagic Copepods and Cladoceres of the Hauraki Gulf," by Dr. Augustin Krämer, Surgeon, H.I.M.S. "Bussard." (*Transactions*, p. 214.)

4. "A Poet's Socialism," by E. A. Mackechnie.

TENTH MEETING: *15th October, 1894.*

Mr. J. H. Upton, President, in the chair.

Professor F. D. Brown gave a popular lecture on "Explosives," illustrated by numerous experiments.

ANNUAL MEETING: *18th February, 1895.*

Mr. J. H. Upton, President, in the chair.

ABSTRACT OF ANNUAL REPORT.

Nine new members joined since the last annual meeting, being a slight increase on the previous year; while fifteen names were withdrawn —three from death, nine from resignation, and three from non-payment of subscription—the number on the roll at the present time being 171.

The total revenue of the General Account is stated at £1,357 10s. 5d., which includes the balance of £53 14s. 7d. from the previous year, and also a temporary advance of £306 6s. 7d. from the Capital Account for purchasing and re-erecting the carved house from Maketu. More than one-third of this amount has already been repaid, and it is expected that the remaining £200 will be repaid before the expiration of two years. Deducting these amounts, the real income was £997 9s. 3d., a marked increase on the previous year. The interest derived from the invested funds of the Costley bequest was £474 12s. 2d.; while the Museum endowment contributed in rents and interest £343 2s. Members' subscriptions yielded £129 3s. The expenditure was £1,283 16s. 1d., leaving a credit

balance of £73 14s. 4d. The invested funds of the Institute are in a satisfactory condition. The total amount at the present time is £12,845, showing an increase of £356 during the year.

As regards the Museum endowments, some small sales of township allotments have been effected. The Council are now negotiating with the Crown Lands Board respecting the utilization of the Tihitihi Block, at Whangarei, the largest of the endowments; and it is hoped that a plan may be decided upon under which the block may be cut up and either sold or leased. The chief difficulty in dealing with the endowments is that there is little demand for country lands except under perpetual lease; and under that system the rents are so small, and are often paid with such irregularity, that the Council are unwilling to adopt it, except in a partial and tentative manner.

Ten meetings were held during the year, at which fourteen papers were read.

The attendance of visitors at the Museum was satisfactory. On Sunday afternoons 9,873 persons visited the building, being an average of 189 for each Sunday. The largest attendance was 334, on the 26th August, and the smallest 34, on the 17th June. The average daily attendance was about a hundred and ten. The approximate week-day attendance is given at 33,000, the total for the year consequently being 41,873. The greatest attendance on any one day was 443, on the 24th May.

The most interesting addition made to the Museum is the Maori House.* The desirability of securing for the City of Auckland such an excellent example of Maori art at a price so reasonable as £150 could not be gainsaid. The house was very carefully taken down and shipped to Auckland, and has since been erected in the centre of the Ethnological Hall. The total cost of its purchase, together with removal and re-erection, has been £306 6s. 7d. The Council record their appreciation of the services rendered by Mr. Fenton in this matter. All the preliminary negotiations for the purchase were made by him; while at considerable personal inconvenience he accompanied the Curator to Maketu to smooth over any difficulties which might arise in completing the purchase. During the re-erection of the house his wide knowledge of the Maori race and its manners and customs was freely available.

Appended to the report will be found a complete list of all additions to the Museum. Many of these are both interesting and valuable.

During the year the following work has been done in the Museum: The rearrangement of the foreign birds, commenced in the previous year, has been completed; several minor changes have been made in the classification of the ethnological collections; the mineralogical collections have been cleaned, rearranged, and relabelled, all recent additions being worked into their proper places; an explanatory series, intended to facilitate the study of the mineral collection by beginners, has been formed, and supplied with descriptive printed labels; the collection of New Zealand fossils, by far the greater proportion of which has never been exhibited to the public, has been cleaned, systematically arranged, mounted, and labelled; the type collection of rocks, purchased some time ago in London, has been more suitably displayed, as also a special collection presented by Mr. Park, intended to illustrate the geology of the Thames Goldfields; the recent shells, both New Zealand and foreign, have also been carefully overhauled and relabelled. In carrying out the above work the Curator has had the help of Mr. Henry Suter.

The library is in a satisfactory state.

At the conclusion of last year's report the Council drew attention to the serious delay in concluding the purchase of the Little Barrier Island,

---

* See p. 674 for description.

and pointed out that the island was being gradually rendered less suitable for the preservation of the New Zealand fauna. At the annual meeting a resolution was passed requesting the Council to urge the Government to complete the purchase; and, in response to this, a deputation of the whole Council waited on the Premier, fully explaining the position of affairs, and the necessity for immediate action. The Premier expressed himself as being anxious and willing to expedite the purchase, and engaged that if the native owners continued to refuse reasonable terms a Bill would be introduced into Parliament providing for the compulsory purchase of the island at a fair valuation. This has since been done, and it is now stated that the Native Land Court has fixed the amount payable to the owners. Probably no long period will elapse before the Government will be the sole owner of the island. If so, the Council trust that no time will then be lost in removing the few Maoris still resident on the island, and in furnishing the caretaker with full powers to prevent unauthorized persons from landing.

Election of Officers for 1895.—*President*—Professor A. P. Thomas, F.L.S.; *Vice-president*—J. H. Upton; *Council*—Rev. J. Bates, W. Berry, Professor F. D. Brown, F.C.S., E. A. Mackechnie, G. Mueller, T. Peacock, J. A. Pond, T. H. Smith, J. Stewart, C.E., Professor H. A. Tubbs, E. Withy; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *18th April, 1894.*

Mr. W. G. Pye, M.A., in the chair.

Paper.—"On a Concrete Conception of Angles and Parallels," by J. R. Wilkinson, M.A.

Second Meeting: *2nd May, 1894.*

Mr. R. M. Laing in the chair.

New Members.—Messrs. A. Dendy, D.Sc., J. J. Kinsey, G. Pitcaithley, S. Hurst Seager.

Papers.—1. "On a New Species of Weta (*Locustidæ*) from Bounty Island," by Captain F. W. Hutton. (*Transactions*, p. 174.)

2. "On the Occurrence of a Pneumatic Foramen in the Femur of a Moa," by Captain F. W. Hutton. (*Transactions*, p. 173.)

Third Meeting: *6th June, 1894.*

Mr. R. M. Laing in the chair.

New Members.—Messrs. T. H. Jackson, B.A., W. A. Carew.

Paper.—"Notes on New Zealand Mosses: Genus *Grimmia*," by R. Brown. (*Transactions*, p. 409.)

Fourth Meeting: *4th July, 1894.*

Mr. R. M. Laing in the chair.

Paper.—"Modern Views of Protoplasm," by R. M. Laing, M.A.

FIFTH MEETING: *1st August, 1894.*

Mr. R. M. Laing in the chair.

Papers.—1. "On *Majaqueus æquinoctialis*, from Antipodes Island," by Captain F. W. Hutton. (*Transactions*, p. 177.)

2. "Notes on New Zealand Land Planarians: Part I.," by A. Dendy, D.Sc. (*Transactions*, p. 177.)

SIXTH MEETING: *5th September, 1894.*

Mr. J. Meeson in the chair.

Papers.—1. "On New Zealand Mosses," by T. W. Naylor-Beckett, F.L.S. (*Transactions*, p. 403.)

2. "On a New Zealand Land Nemertine," by A. Dendy, D.Sc. (*Transactions*, p. 191.)

3. "On a New Variety of *Peripatus novæ-zealandiæ*, Hutton," by A. Dendy, D.Sc. (*Transactions*, p. 190.)

SEVENTH MEETING: *3rd October, 1894.*

Mr. R. M. Laing in the chair.

Papers.—1. "On the Axial Skeleton in the Dinornithidæ," by Captain F. W. Hutton. (*Transactions*, p. 157.)

2. "On the Conditions of Equilibrium of Free Gaseous Cosmical Bodies under Varying Conditions of Volume, Composition, Temperature, and Mass," by Professor Bickerton.

3. "Curves of Gravitation," by Professor Bickerton.

4. "The Immortality of the Cosmos; being an Attempt to show that the Theory of Dissipation of Energy is limited to Finite Portions of Space," by Professor Bickerton. (*Transactions*, p. 538.)

5. "On an Oversight in Croll's Mode of lengthening the Age of the Sun's Heat," by Professor Bickerton. (*Transactions*, p. 558.)

6. "On Disposing Affinity and the Constitution of difficultly-decomposable Cyanides," by Professor Bickerton.

ANNUAL MEETING: *7th November, 1894.*

Mr. R. M. Laing in the chair.

Papers.—1. "Note on the Observation of Microseismic Waves," by G. Hogben, M.A.

2. "Note on Land Planarians of New Zealand," by A. Dendy, D.Sc.

3. "Magnetization of Iron by High-frequency Discharges," by E. Rutherford, M.A. (*Transactions*, p. 481.)

4. "Notes on New Zealand Mosses: Genus *Orthotrichum*," by R. Brown. (*Transactions*, p. 422.)

5. "On Six Pieces of Apparatus to determine experimentally the various Lines of Force upon which Scientific Apparatus is founded," by Professor Bickerton.

6. "On Molecular Attraction," by Professor Bickerton.

7. "On the Specific Heat of the Elements, deduced from the Specific Heat of Compound Gases at Constant Volume," by Professor Bickerton.

8. "On Chlorine as a Cure for Consumption," by Professor Bickerton.

9. "On Hail," by Professor Bickerton.

10. "On a Simple Classification of Organic Compounds," by Professor Bickerton.

11. "On a Simple Mode of representing the Graphic Constitution of Organic Bodies," by Professor Bickerton.

12. The Presidential Address on "The Algæ of New Zealand," by R. M. Laing, M.A., B.Sc. (*Transactions*, p. 297.)

Abstract of the Annual Report.

During the year seven ordinary meetings have been held, at which twenty-six papers have been read. These may be classified as follow: Zoology, 6; geology, 2; botany, 3; chemistry, 3; physics, 11; pure mathematics, 1. This list shows a slight increase as compared with last year's.

The membership now stands at sixty-six, which is the same as last year; but the number of associates has risen to seventy-six.

The library has been increased by the usual periodicals and donations, but it has been enriched especially by the Proceedings of the Linnæan Society of New South Wales.

The photographic section still continues to be a flourishing branch of the Institute. The attendance at its meetings is very large, and in September it held one of the most successful exhibitions ever held in the colony.

The balance-sheet shows that the total receipts for the year have been £80 2s. 5d., and the total expenditure £71 1s. 6d., which, with last year's balance of £32 10s., leaves a credit balance of £41 10s. 11d.

Election of Officers for 1895. — *President* — Dr. A. Dendy; *Vice-presidents*—Dr. W. Thomas, Mr. R. M. Laing; *Hon. Secretary*—Mr. R. Speight; *Hon. Treasurer*—Mr. J. T. Meeson; *Council*—Dr. W. H. Symes, Professor Bickerton, Dr. W. P. Evans, Messrs. H. R. Webb, S. Hurst Seager, S. Page.

OTAGO INSTITUTE.

FIRST MEETING: *22nd May, 1894.*

Mr. Edward Melland, President, in the chair.

New Members.—F. J. Bews, Henry Williams.

Professor F. B. de M. Gibbons read a paper on "The Appreciation of Gold."

SECOND MEETING: *19th June, 1894.*

Mr. Edward Melland, President, in the chair.

Professor Parker gave an account of the characteristics and the life-history of the principal parasitic worms infesting man.

Mr. G. M. Thomson gave an account of the structure and systematic position of *Anaspis*, a newly-discovered annectant form of Arthrostracous Crustacea.

Mr. A. Hamilton read a paper on moa-feathers, summarizing the present information on the subject, and giving particulars of the finding of a large number of feathers of *Megalapteryx* in a cave on the Old Man Range, at the head of the Waikaia River. (*Transactions*, p. 232.)

THIRD MEETING: *17th July, 1894.*

Mr. Edward Melland, President, in the chair.

The President read a paper "On the Financial Depression, its Cause and Remedy."

FOURTH MEETING: *14th August, 1894.*

Mr. Edward Melland, President, in the chair.

New Member.—C. Howard Jackson.

Professor Parker drew attention to a large and valuable collection of ethnological specimens from New Guinea, recently presented to the Museum by the Rev. James Chalmers.

The Rev. Dr. Belcher read a paper "On some Female Characters in the Plays of Sophocles."

FIFTH MEETING: *11th September, 1894.*

Mr. Edward Melland, President, in the chair.

New Member.—Dr. W. M. Smith.

Dr. Hocken read a paper on the earliest literature relating to New Zealand, and also traced the voyages of the earliest-known explorers by the aid of maps and of copies of rare and curious charts. (*Transactions*, p. 616.)

SIXTH MEETING: *9th October, 1894.*

Dr. Hocken, Vice-president, in the chair.

The Rev. Dr. Belcher read a paper "On Recent Discoveries at Megalopolis, in Arcadia," illustrating his remarks by drawings and plans of the theatre and other buildings, and explaining the bearing of the recently-discovered facts upon our knowledge of the Greek theatre.

Professor Parker exhibited and made remarks upon the leg of a moa (*Megalapteryx*) recently found in a cave at the Old Man Range, at the head of the Waikaia River. The specimen, which is the property of Mr. A. Hamilton, is in a remarkably fine state of preservation, considerable portions of skin, muscle, tendons, and feathers being retained, the study of which has added several minor facts to our knowledge of the *Dinornithidæ*.

Professor Parker drew attention to skeletons of rhinoceros, moose, eland, and elephant lately added to the Museum, and to the polished transverse section of a large kauri-tree presented by the Public Works Department.

The Secretary read a paper by Mr. D. Petrie, entitled "Descriptions of New Native Plants." (*Transactions*, p. 405.)

SEVENTH MEETING: *13th November, 1894.*

Mr. Edward Melland, President, in the chair.

Professor Parker exhibited and made remarks upon a collection of New Zealand fishes, mounted in alcohol in such a way as to display their form to great advantage. The majority of the specimens were collected by Mr. F. Sandager at Mokohinou, in 1889, and were by him presented to the Museum.

Mr. A. Hamilton read a paper on his recent visit to Macquarie Island on behalf of the Museum, giving an account of his observations on the topography, zoology, and botany of

the island, and of the collections made by Mr. E. Jennings, taxidermist to the Museum, and himself. (*Transactions*, p. 559.) The paper was illustrated by numerous photographs taken by the author, a painting of a king-penguin rookery by Miss Hamilton, and several specimens.

Mr. G. M. Thomson read a paper "On some Crustacea from Macquarie Island." (*Transactions*, p. 210.)

ANNUAL MEETING: *13th November, 1894.*

Mr. Edward Melland, President, in the chair.

ABSTRACT OF ANNUAL REPORT.

During the session seven ordinary meetings and ten Council meetings have been held.

Eleven papers have been read: four on geological, one on botanical, and six on general subjects. Five new members have joined; and the Council has to regret the loss of Mr. D. Petrie, M.A., who has removed to Auckland, and of Mr. D. Wilkinson, A.R.S.M., who has left New Zealand.

The Council has nominated Mr. J. McKerrow to vote in the election of Governors of the New Zealand Institute, and Dr. Anton Dohrn, of the Zoological Station, Naples, as honorary member of the New Zealand Institute.

Satisfaction is expressed at the appointment of a curator (Mr. R. Henry) to the reserve for native birds at Resolution Island, and the regret of the Council is once more recorded that no steps have yet been taken towards the publication of a new Flora of New Zealand.

The balance-sheet showed the total receipts for the year to be £76 6s., which, together with the balance of £72 17s. 9d. brought forward from last year, made a sum of £150 3s. 9d. The expenditure for the year was £124 7s. 6d., leaving a credit balance of £25 16s. 3d.

ELECTION OF OFFICERS FOR 1895.—*President*—Charles Chilton, D.Sc.; *Vice-presidents*—Edward Melland, Augustus Hamilton; *Hon. Secretary* — Professor T. Jeffery Parker, D.Sc., F.R.S.; *Hon. Treasurer* — Professor F. B. de M. Gibbons, M.A.; *other Members of Council*—T. M. Hocken, M.R.C.S., F.L.S., Professor John H. Scott, M.D., F.R.S.E., the Rev. Henry Belcher, M.A., LL.D., Frederick R. Chapman, C. W. Adams, C.E., J. S. Tennant, B.A., B.Sc., G. M. Thomson, F.L.S.; *Auditor*—Daniel Brent, M.A.

WESTLAND INSTITUTE.

Annual Meeting: *December, 1894.*

Abstract of Annual Report.

The report of the trustees contained a fair exposition of the working of the society, its present position, future prospects, and desire for further expansion. The financial statement showed a fairly well balanced income and expenditure, but no margin to allow of any improvements to be undertaken, and only a very small credit. The members' roll contains sixty subscribers. The thanks of the society were unanimously conveyed to the Borough Council for their annual subsidy. The trustees' meetings have been well attended, and considerable work has been done by them for the benefit of the Institute. The public reading-room has been well supplied with the leading papers, and is a great convenience, and largely attended. The trustees desired to convey their thanks to those publishers who give papers to the free reading-room. The balance-sheet showed a revenue of £116 12s. 11d., and an expenditure of £116 3s.

Election of Officers for 1895.—*President*—A. H. King; *Vice-president*—D. Macfarlane; *Hon. Treasurer*—T. O. W Croft; *Trustees*—J. Chesney, A. Mahan, D. Barron, H. L. Michel, J. Churches, A. E. Cresswell, W. L. Fowler, T. H. Gill, A. J. Morton, R. W. Wade, Dr. Macandrew, and Dr. Kendall.

MARINE BIOLOGICAL LABORATORY
WOODS HOLE
LIBRARY
MASS.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *21st June, 1894.*

Mr. T. Humphries, President, in the chair.

Paper.—"Spectacles," by Dr. F. W. Innes.

The paper was illustrated by diagrams and models.

Second Meeting: *9th July, 1894.*

Mr. J. W. Carlile, Vice-president, in the chair.

Papers.—1. "On the Occurrence of Moa-footprints in the Bed of the Manawatu River, near Palmerston North," by H. Hill, B.A., F.G.S. (*Transactions*, p. 476.)

2. "On the Hawke's Bay Pleistocene Beds and the Glacial Period: Part I.," by H. Hill, B.A., F.G.S. (*Transactions*, p. 451.)

The first paper was illustrated by drawings and casts.

Third Meeting: *13th August, 1894.*

Mr. H. Hill in the chair.

Papers.—1. "Notes and Reminiscences of Early Crossings of the Romantically-situated Lake Waikaremoana, County of Hawke's Bay, of its Neighbouring Country, and of its Peculiar Botany; performed in the Years 1841 and 1843," by W. Colenso, F.R.S., F.L.S. (Lond.), &c. (*Transactions*, p. 359.)

2. "Some Curious and Little-known Information and Memoranda relating to Letters and Mails in the Olden Time," by W. Colenso, F.R.S., F.L.S. (Lond.), &c.

FOURTH MEETING: *10th September, 1894.*

Rev. W. Colenso, F.R.S., in the chair.

Paper.—"On Corals and Coral Islands," by Dr. Moore.

FIFTH MEETING: *8th October, 1894.*

Mr. H. Hill in the chair.

Papers.—1. "The Kea (*Nestor notabilis*), a Sheep-eating Parrot," by Taylor White. (*Transactions*, p. 273.)

2. "On the Bird Moa and its Aliases," by Taylor White. (*Transactions*, p. 262.)

3. "Remarks on the Rats of New Zealand," by Taylor White. (*Transactions*, p. 240.)

SIXTH MEETING: *12th November, 1894.*

Mr. T. Humphries, President, in the chair.

Papers.—1. "Memorabilia of certain Animal Prodigies, Native and Foreign, Ancient and Modern," by W. Colenso, F.R.S., F.L.S. (Lond.), &c.

2. "The Modern History of a Block of Greenstone," by W. Colenso, F.R.S., F.L.S. (Lond.), &c. (*Transactions*, p. 598.)

3. "Description of a few Newly-discovered and Rare Indigenous Plants," by W. Colenso, F.R.S., F.L.S. (Lond.), &c. (*Transactions*, p. 383.)

4. "The Nuhaka Hot Springs," by H. Hill, B.A., F.G.S. (*Transactions*, p. 478.)

5. "The Hawke's Bay Pleistocene Beds and the Glacial Period: Part II.," by H. Hill, B.A., F.G.S. (*Transactions*, p. 466.)

At the close of the meeting, the President, in the name of the Institute, presented to Mr. Colenso a fine portrait in oils of himself, by Herr Lindauer.

In making the presentation, Mr. Humphries referred to the valuable services rendered to the Institute by Mr. Colenso by his scientific researches. The members of the society had for some time thought that some remembrance of the work Mr. Colenso had done for the Institute should be obtained, and he was exceedingly pleased they had secured so fine a representation of the pillar and founder of the institution.

Mr. Hill, on being called on by the President to say a few words, said it gave him great pleasure to be present on such an occasion, because it seemed to him that they were for once trying to carry out the object which the society had had in view for a number of years past. While in their midst they had a man of scientific attainments such as were recognized in Europe and America, yet he (the speaker) often wondered whether Mr. Colenso was as well known here in this town, where he had resided for half a century, as the ordinary handicapper or jockey who rode in a race. They had a man amongst them of whom the citizens of Napier, and other inhabitants of New Zealand, should be proud. Whilst listening to Mr. Colenso reading his remarkable papers those present must have been struck by the variety of knowledge which he brought forward from time to time to interest and instruct. Year after year the same untiring energy was manifested by him, and that, too, at an age when most men would have given up pursuits of a scientific nature. Mr. Colenso still came to them trying to point out the pathways of science which he himself had trodden with pleasure—a pleasure that he transmitted to his audience. Was it not sufficient to urge the younger members on, to think that here was a gentleman of over fourscore years, who yet followed the hobby of his life, and was yet desirous of leaving a record behind him of things he had seen, of conclusions he had arrived at from his scientific pursuits? He (Mr. Hill) had looked upon Mr. Colenso as a teacher; and he had never been in his presence without feeling that his life was an example, a sermon, and everything that was good and noble. He was pleased to think that the Philosophical Society was at last trying to recognize its duty towards the founder of the Institute. Mr. Colenso had nursed the society since its inception, and looked after it until it had come to be known throughout New Zealand as one of the strongest in the colony. The present members of the society did not need anything to remind them of Mr. Colenso's qualities of goodness, but they must remember that nature in time to come would demand her own, and he, like all others, must pass away. Those who came after would need a reminder, and, when they saw this picture hanging in the Museum which would become theirs some day, they would know that it was the picture of a good and gracious man. He trusted that there were many years before Mr. Colenso yet in which he would come amongst them, and inspire them as he had inspired them in days gone by, and that he would be encouraged by this small effort which the society had made to keep him in remembrance.

The Rev. Mr. Colenso, in returning thanks for the present, said he hardly knew what to say, so many things in his remembrance were crowding into his mind. The coming month of December would make it sixty years since he first came to Hawke's Bay, having landed in company with the late Bishop Williams, first Bishop of Waiapu, and the bishop elect, who was then a mere boy. Since his arrival in Napier on that occasion he had resided here up till the present time. Mr. Colenso then went on to refer briefly to his connection with the Hawke's Bay Philosophical Institute, remarking that, though he last year to all intents and purposes bade farewell to the Institute, it had pleased God to restore him to health and vigour. He also referred to the services rendered by Mr. Hamilton as Curator before his removal to Dunedin, who, by his interest and whole-heartedness in the work, was, in a very large measure, responsible for the splendid collection of specimens the society now held. He (Mr. Colenso) hoped the time would come, and at no distant period, when the Institute would own a museum, where their valuable specimens could be properly taken care of. In conclusion, he asked the society to accept the picture as a present from him.

Annual Meeting: *4th February, 1895.*

Abstract of Annual Report.

Six ordinary meetings were held, and were well attended. The number of papers read was fourteen. The financial position of the Institute continues to be satisfactory. The Council regret, however, a considerable decrease in the membership, which now stands at 84, the smallest number for many years past. The same decrease is apparent in other branches of the Institute. During the year twenty volumes have been added to the library.

A fine portrait of the founder and former Secretary of this branch, the Rev. W. Colenso, F.R.S., F.L.S., &c., which was painted by Herr Lindauer to the order of the Council, has been presented by Mr. Colenso to the Institute, and now hangs on the wall of the Museum. The likeness is a capital representation of one of the pioneers of science in this colony.

The accounts show that the total receipts were £76 7s. 11d., and that the assets were valued at £827 18s. 3d.

Election of Officers for 1895.—*President*—J. W. Carlile, M.A.; *Vice-president*—H. H. Pinckney, B.A.; *Council*—T. Humphries, J. W. Craig, H. Hill, B.A., F.G.S., J. S. Large, G. Pitcaithley, B.A., Dr. A. Milne-Thompson; *Hon. Secretary*—W. Dinwiddie; *Hon. Treasurer*—G. White; *Auditor*—J. Crerar.

NELSON PHILOSOPHICAL SOCIETY.

FIRST MEETING: *12th February, 1894.*

Mr. A. S. Atkinson, Vice-president, in the chair.

New member.—Mr. W. Davies.

Dr. J. Hudson gave a description of a trip to the neighbourhood of Mount Cook.

Exhibits.—Photographs of Mount Cook, &c., by Mr. F. W. Gibbs. Pair of *Spondylus* shells from Red Sea; pair of living *Paryphanta hochstetteri*, from Mount Duppa; living *Naultinus pulcherrimus*, by Mr. E. Lukins. Nest of *Bombus terrestris*, with comb, by Mr. A. S. Atkinson. Stems of *Plantago lanceolata*, showing peculiar variations, by Mr. R. I. Kingsley.

SECOND MEETING: *12th March, 1894.*

Mr. A. S. Atkinson, Vice-president, in the chair.

Papers.—1. "On the Presence of some Noxious Weeds in Nelson District"—*Carduus arvensis, Arctium minor,* and *Melilotus arvensis*—by R. I. Kingsley. (*Transactions*, p. 407.)

2. "Zoological Notes: (1.) Arboreal Nests of Bush-rat (*Mus maorium*); (2.) *Paryphanta hochstetteri* found at Low Levels at West Wanganui," by R. I. Kingsley. (*Transactions*, p. 238.)

3. "Botanical Notes: Plants new to Nelson Province, &c., from West Wanganui," by R. I. Kingsley. (*Transactions*, p. 407.)

A quantity of plants and New Zealand land-snails, also spherical iron-ore from West Wanganui, were exhibited by Mr. R. I. Kingsley.

A lamprey was presented by Dr. Hudson.

THIRD MEETING: *9th April, 1894.*

Mr. A. S. Atkinson, Vice-president, in the chair.

Exhibits.—Nest of rat found in a hedge, by Mr. A. S. Atkinson; some rare endemic plants, by Mr. R. I. Kingsley; *Poranthera microphylla*, and several specimens of *Veronica* of rare forms, &c.

FOURTH MEETING: *18th June, 1894.*

Mr. A. S. Atkinson, Vice-president, in the chair.

Mr. A. S. Atkinson read an appendix to his notes on the Maori-Polynesian Dictionary.

Mr. Kingsley read an article by the Rev. Theodore Wood, F.L.S., "On the Apparent Cruelty of Nature."

Mr. E. Lukins exhibited fruit of coco-de-mer from Seychelles Islands.

FIFTH MEETING: *30th August, 1894.*

The Bishop of Nelson, President, in the chair.

Dr. Hudson read an article "On the Bacilli of Tetanus."

Mr. Kingsley read a paper "On Tombs of a Prehistoric Race of Colombia, South America," exhibiting diagrams to illustrate the same. (*Transactions*, p. 606.)

Presentations.—From Mr. C. James, third engineer of s.s. "Hinemoa": Pair of large limpets from Kermadec Islands; pair of candleberry nuts from Rarotonga Island.

Mr. Huffam exhibited a live lizard and young ones (*Naultinus elegans*).

The following resolution was passed: "That the attention of the Board of Governors of the New Zealand Institute be directed to the importance, in the interests of science, of Mr. Atkinson's criticism of Mr. Tregear's Maori-Polynesian Dictionary, and that the Board be asked to publish it in the Transactions of the Institute."

SIXTH MEETING: *5th November, 1894.*

Mr. A. S. Atkinson, Vice-president, in the chair.

Paper.—"On the Preparation and Preservation of Botani-

cal Specimens," by T. Kirk, F.L.S. (read by Mr. Joynt). (*Transactions*, p. 318.)

Presentations.—Empty artillery-shell from Haerangi Pa, by Mr. Victor Glanville; basket from Fiji, by Miss Martin.

Annual Meeting: *10th December, 1894.*

The Bishop of Nelson, President, in the chair.

Paper.—"On New Forms of Celmisia," by T. Kirk, F.L.S. (read by the Hon. Secretary). (*Transactions*, p. 327.)

Exhibits.—Mr. E. Lukins exhibited specimens of birds and their eggs, land and marine shells, and Maori implements from Stephen's and D'Urville Islands.

Presentations.—Specimen of tin-ore from the Buller, by Mr. G. Pitts; a fish, a species of trout, by Mr. Thorpe.

Abstract of Annual Report.

The report of the Hon. Secretary showed an increase in the number of meetings held, but regretted that the attendance had not improved.

The Hon. Curator's report showed the Museum to be in fair condition, considering that it is not endowed.

The Hon. Treasurer's report showed a small balance carried forward.

Election of Officers for 1895.—*President*—The Bishop of Nelson; *Vice-presidents*—Mr. A. S. Atkinson, Dr. J. W. Mackie; *Hon. Secretary*—Mr. R. I. Kingsley; *Hon. Treasurer*—Dr. J. Hudson; *Council*—Dr. Boor, Messrs. E. Lukins, F. Worley, J. Holloway, and J. G. Bartell; *Hon. Curator of Museum*—Mr. R. I. Kingsley; *Assistant Curator*—Mr. E. Lukins.

The President gave a short address "On the Importance of the Study of Natural History, &c."

APPENDIX

METEOROLOGY.

Comparative Abstract for 1894 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Degree of Moisture (Saturation = 100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and Date.	Mean Amount (0 to 10).
Auckland	30·043	1·140	59·7	12·9	47·0	148·0	30·0	0·407	78	41·110	180	...	...	5·4
Previous 30 years ...	29·990	...	59·2	...	...	...	...	0·388	73	42·182	182	...	...	...
Wellington	29·960	1·598	56·4	12·0	46·7	145·0	21·0	0·334	73	51·006	175	218	680 on 13th	4·7
Previous 30 years ...	29·929	...	54·8	...	...	...	...	0·335	73	50·798	159	...	Nov.	...
Dunedin	29·880	1·797	51·0	14·9	57·0	152·0	27·0	0·282	74	39·436	151	151	560 on 22nd	5·3
Previous 30 years ...	29·980	...	50·2	...	...	...	...	0·277	73	36·297	159	...	Aug.	...

Average Temperature of Seasons, compared with those of the Previous Year.

Stations.	Spring. September, October, November.		Summer. December, January, February.		Autumn. March, April, May.		Winter. June, July, August.	
	1893.	1894.	1893.	1894.	1893.	1894.	1893.	1894.
Auckland	60·4	57·6	66·2	67·8	61·3	60·3	54·2	53·1
Wellington	57·5	54·6	61·5	64·1	57·1	57·3	50·7	49·6
Dunedin	52·6	50·8	56·4	59·5	50·9	50·7	43·5	43·3

REMARKS ON THE WEATHER DURING 1894.

JANUARY.—Fine in North; showery over centre, especially during latter part; and wet and unpleasant in South; generally moderate winds.

FEBRUARY.—Latter part showery in North; very wet over centre, and strong N.W. and S.E. winds; and showery and cold weather in South, with prevailing S.W. winds.

MARCH.—Fine in North, with prevailing S.W. wind; still showery over centre, chiefly from N.W.: and wet in South, with prevailing moderate S.W. winds.

APRIL.—Generally fine weather throughout; strong N.W. winds over centre, otherwise moderate; rather showery in extreme South.

MAY.—Showery weather generally, with moderate variable winds; high winds in South from S.W.

JUNE.—A wet month generally, with prevailing strong S.E. and N.W. winds.

JULY.—Showery in North and over centre, and strong winds with thunder on 10th, 19th, and 20th, and hail on 20th and 26th; fine in South, and light winds.

AUGUST.—Wet in North, and strong S.W. winds, with thunder on 2nd and 29th; over centre showery, but some fine days, prevailing N.W. wind and strong during end of month; in South showery, but moderate rainfall, prevailing S.W. winds.

SEPTEMBER.—In the North unpleasant showery weather, with strong N.E. and S.W. winds, frequent thunder and hail; also showery over centre, with prevailing southerly winds and strong; in South wet early part, but fine towards end of month, with moderate winds.

OCTOBER.—Very fine, bright, dry weather throughout during this period, with moderate winds.

NOVEMBER.—Weather generally showery throughout, with strong N.W. winds over centre; and hailstorms in South on 3rd and 27th.

DECEMBER.—Very fine in North, with fresh N.E. winds towards end; also fine over centre, with prevailing N.W. winds; fine in South, with prevailing W. winds.

EARTHQUAKES reported in NEW ZEALAND during 1894.

PLACE.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Thames ..	..	..	..	.	8*	..	..	..	..	..	..	..	1
Auckland ..	..	..	..	..	8*	..	..	..	..	..	25*	..	2
Rotorua ..	..	..	..	..	..	..	2*	..	..	..	..	..	1
Napier ..	..	..	..	..	..	..	19*	..	..	..	..	..	1
New Plymouth	..	..	..	..	21	..	..	..	..	..	..	..	1
Wanganui ..	..	..	..	..	21*	..	..	..	..	..	..	..	1
Shannon ..	..	..	..	2*	21*	..	..	..	..	..	..	..	2
Palmerston N.	11	..	..	..	..	..	..	..	..	..	..	..	1
Kaitoke ..	..	..	..	..	..	..	9	..	..	..	..	..	1
Hawera ..	..	..	..	2*	21*	..	9*	..	..	..	..	..	3
Featherston..	..	..	..	2*	..	..	..	..	..	..	..	..	1
Woodville ..	..	..	..	..	21*	..	9	..	..	..	..	..	2
Masterton ..	..	..	..	2*	..	..	..	..	..	..	..	4*	2
Wellington ..	11	..	12, 18*	2*	21*	..	9	..	16	2	..	..	8
Greytown ..	..	..	..	2*	..	..	..	..	..	..	..	..	1
Nelson ..	..	..	..	..	21*	..	..	..	..	..	..	..	1
Blenheim ..	..	..	..	2*	21*	..	..	..	..	..	..	..	2
Christchurch	..	..	..	..	21*	..	..	29*	..	..	..	3*, 4*	4
Lincoln ..	..	..	..	..	..	..	..	31	..	..	..	4	2
Lyttelton ..	..	..	..	..	..	..	..	29*	..	..	..	..	1
Hokitika ..	..	..	..	..	..	..	..	..	..	..	..	4	1
Dunedin ..	..	..	..	24	7, 18*	..	..	..	..	..	..	4	4
Invercargill ..	..	..	..	..	7*	..	..	..	..	..	..	4*	2

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. These tables are therefore not reliable as far as indicating the geographical distribution of the shocks.

NEW ZEALAND INSTITUTE.

HONORARY MEMBERS.

1870.

FINSCH, OTTO, Ph.D., of Bremen
FLOWER, W. H., F.R.S., F.R.C.S.
HOOKER, Sir J. D., K.C.S.I., C.B., M.D., F.R.S.
VON MUELLER, Baron Sir FERDINAND, K.C.M.G., M.D., F.R.S.
RICHARDS, Admiral Sir G. H., C.B., F.R.S.

1872.

GREY, Sir GEORGE, K.C.B., P.C., D.C.L.
HUXLEY, THOMAS H., P.C., LL.D., F.R.S.

1873.

BOWEN, Sir GEORGE FERGUSON, G.C.M.G., P.C.
CAMBRIDGE, The Rev. O. PICKARD, M.A., C.M.Z.S.
GÜNTHER, A., M.D., M.A., Ph.D., F.R.S.

1874.

MCLACHLAN, ROBERT, F.L.S.
NEWTON, ALFRED, F.R.S.

1875.

SCLATER, PHILIP LUTLEY, M.A., Ph.D., F.R.S.

1876.

ETHERIDGE, Prof. ROBERT, F.R.S.
BERGGREN, Dr. S.

1877.

SHARP, Dr. D.

1878.

MÜLLER, Professor MAX, F.R.S.

1883.

Lord KELVIN, P.R.S.
ELLERY, ROBERT L. J., F.R.S.

1885.

SHARP, RICHARD BOWDLER, M.A., F.L.S.
WALLACE, A. R., F.L.S.

1888.

MCCOY, Professor Sir F., K.C.M.G., Sc.D., F.R.S.
VON ETTINGSHAUSEN, Baron C.

1890.

RILEY, Professor C. V.
NORDSTEDT, Professor OTTO, Ph.D.
LIVERSIDGE, Professor A., M.A., F.R.S.

1891.

GOODALE, Professor G. L., M.D., LL.D.
DAVIS, J. W., F.G.S., F.L.S.

1894.

DYER, Professor THISELTON-, M.A., C.M.G., F.R.S.
CODRINGTON, Rev. R. H., D.D.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life-members.]

Adams, Dr.
Allen, F.
Anson, Dr.
Atkinson, A. R.
Atkinson, A. S., Nelson
Baldwin, P. E.
Barnes, R. J.
Baron, J. Suckling
Barraud, W. F.
Barron, C. C. N.
Barton, W.
Batkin, C. T.
Beetham, G.
Beetham, W. M.
Bell, E. D.
Best, E., Hadfield
Blair, J. R.
Bold, E. H., C.E., Napier
Bothamley, A. T.
Brandon, A. de B.
Brown, W. R. E.
Buchanan, John, F.L.S.*
Buller, Sir W. L., K.C.M.G., D.Sc., F.R.S.
Caldwell, R.
Campbell, J. P.
Carlile, W. W., M.A.
Chapman, Martin
Chapple, Dr.
Chudleigh, E. R.
Cohen, W. T.
Colenso, W., F.R.S., F.L.S., &c., Napier
Connal, E.
Dasent, Rev. A.
Davis, J. W.
Davy, Dr. T. G., Kumara
Dawson, B.
Denton, George
Drew, S. H., Wanganui
Duthie, J.
Elliot, Major E. H. J.
Evans, W. P., M.A., Ph.D.
Ewart, Dr.
Farquhar, H.
Ferard, B. A., Napier
Ferguson, W., C.E.
Field, H. C., Wanganui
Fraser, F. H.
Freeman, H. J.
Gillespie, C. H.
Gordon, H., F.G.S.
Gore, R. B.
Grace, Hon. M. S., C.M.G., M.D.
Hadfield, E. F.
Hanify, H. P.
Harcourt, J. B.
Harding, R. Coupland
Hawthorne, E. F.
Hector, Sir James, K.C.M.G., M.D., F.R.S.
Henley, J. W.
Herbert, W. H.
Higginson, H. P., M.Inst.C.E
Holmes, R. L., F.R. Met. Soc., Fiji*
Holmes, R. T., Masterton
Hudson, G. V., F.E.S.
Hughes, H., M.I.M.E.
Hulke, C., F.C.S.
Hustwick, T. H.
Inwood, D., Canterbury
Johnson, Hon. G. Randall*
Kenny, Hon. Captain C.
King, T.
Kirk, H. B., M.A.
Kirk, Thomas, F.L.S.
Kirk, T. W., F.L.S.
Kirk, W. L.

Krull, F. A., Wanganui
Lambert, T. S.
Lee, H. M.
Lee, R.
Liffiton, E. N., Wanganui
Litchfield, A. J., Blenheim
Logan, H. F.
Lomax, H. A., Wanganui
Mackenzie, F. Wallace, M.B.
Malcolm, Miss J.
Mantell, Hon. W. B. D., F.G.S.
Marchant, J. W. A.
Martin, Dr. A.
Maskell, W. M.
Mason, Thomas, Hutt
Maxwell, J. P., M.Inst.C.E.
McKay, Alexander, F.G.S.
McLeod, H. N.
McWilliam, Rev. W., Otaki
Mestayer, R. L., M.Inst.C.E.
Molineaux, B. M.
Murdoch, R., Wanganui
Nairn, C. J., Hawke's Bay
Newman, Alfred K., M.B., M.R.C.P.
Ogg, Rev. C. S.
Orr, Robert
Park, R. G.*
Pearce, E.
Pharazyn, C., Wairarapa
Pharazyn, Hon. R., F.R.G.S.
Phillips, Coleman
Pierard, C. H.
Pollen, Hugh
Pollen, Dr.
Powles, C. P.
Poynton, J. W.
Prendergast, Sir J., Chief Justice
Reid, W. S.
Richardson, C. T.
Richmond, Mr. Justice
Rowse, Rev. W., Greytown
Roy, R. B., New Plymouth
Rutherfurd, A. J.
Rutherfurd, W. G.
Samuel, E.
Schaw, Major-General, C.B., R.E.
Simcox, W. H., Otaki
Sinclair, J.
Skerman, Dr. Sydney, Marton
Skey, W.
Smith, C. O'Hara
Smith, Charles, Wanganui
Smith, S. Percy, F.R.G.S.
Stewart, J. T., Wanganui
Stowell, H. M.
Stuart, A. P.
Tait, P. W.
Tait, R.
Tanner, Cyril
Teare, Dr.
Tod, Andrew, Wanganui
Travers, W. T. L., F.L.S.
Tregear, E.
Turnbull, A. H., London
Turnbull, R. T.
Turnbull, Thomas
Wallace, James
Waterhouse, G. M., F.R.G.S.
Wilton, G. W.
Woodhouse, Alfred James, London
Wright, H.

AUCKLAND INSTITUTE.

[*Honorary and life members.]

Adams, J., B.A., Thames
Aickin, G., Auckland
Aitken, W. ,,
Allen, T. ,,
Argall, W. H., Coromandel
Arnold, C., Auckland
Bagnall, L. J., Thames
Baker, Rev. S. W., Auckland
Bakewell, R. H., M.D., Auckland
Ball, T., Onehunga
Ball, W. T., Auckland
Bartley, E., Devonport
Bates, Rev. J., Devonport
Bates, T. L., Newcastle, N.S.W.*
Batger, J., Auckland
Beere, D. M., C.E., Gisborne
Berry, W., Auckland
Brett, H. ,,
Brigham, J. M., Auckland
Brock, A. ,,
Brookes, E. S., jun., Wharehine
Broun, Captain T., F.E.S., Drury
Brown, J., Epsom
Brown, Prof. F. D., Auckland
Buchanan, J. ,,
Buchanan, W., Devonport
Buckland, A., Auckland*
Buckland, W. F., Remuera
Bull, G. W., Thames
Burgess, E. W., Devonport
Burton, Colonel, Lake Takapuna*
Cameron, R., Auckland
Campbell, H. ,,
Campbell, J. L., M.D., Auckland
Carr, R. C., Remuera
Cheal, P. E., Auckland
Cheeseman, T. F., F.L.S., Auckland
Ching, T., Parnell
Choyce, H. C., Auckland
Cochrane, W. S., Auckland
Colbeck, Captain, Epsom
Combes, F. H., Auckland
Cooper, C. ,,
Cooper, T. ,,
Cowie, Rt. Rev. W. G., D.D., Bishop of Auckland
Cozens, G., Auckland
Craig, E. ,,
Cruickshank, D. B., Auckland
Cussen, L., ,,
Darby, P., ,,
Davies, Rev. H. S., Northcote
Dawson, F.W.E., M.R.C.S.E., Auckland
Dignan, P. L., Auckland
Dufaur, E. T. ,,
Eastham, S., Devonport
Edson, J. ,,
Egerton, Prof. C. W., Auckland
Ehrenfried, L., Auckland
Ewington, F. G. ,,
Farmer, J., London
Fenton, F. D., Kaipara
Fidler, W., Northcote
Firth, J. C., Auckland
Fowlds, G. ,,
Garlick, R. ,,
George, C. S. ,,
Girdler, Dr. ,,
Goldie, D. ,,
Gorrie, W. ,,
Grace, L. M., Taupo
Graham, W. K., London
Gray, A., Remuera
Haines, C. H., M.D., F.R.G.S., Auckland
Haines, H., M.R.C.S., Auckland
Hardie, J., Auckland
Harding, S., C.E., Auckland

Harris, J. D., Opua
Haszard, H. D. M., Auckland
Haultain, Hon. Col. ,,
Henton, J. S. ,,
Herbert, T., Parnell
Hesketh, E., Auckland
Hill, W. J. ,,
Hosking, A. A., Mount Eden
Johnson, H. D., Te Aroha
Kenderdine, J., Auckland
Kidd, A. ,,
Kirk, T., F.L.S., Wellington*
Kirker, J., Auckland
Kitt, T. W., Auckland*
Leaf, C. J., F.L.S., F.G.S., London*
Lennox, J. M., Auckland
Lennox, N. G., Sydney*
Leys, T. W., Auckland
MacArthur, J. P., London
Mackechnie, E. A., Auckland
Mackellar, E. D., M.D., Parnell
Macmillan, C. C., Auckland
Mahoney, T., ,,
Mair, Capt. G., Foxton
Mair, R., Whangarei
Mair, Major W. G., Auckland
Malfroy, C., Rotorua
Martin, J., F.G.S., Auckland
Masefield, T. T. ,,
McCullough, Hon. W. ,,
McLachlan, J. M. ,,
McLaurin, J. ,,
Meinertzhagen, F. M., Napier*
Mitchell, J., Auckland
Moat, W. P., Mahurangi
Monro, H. A. H., Parnell
Moody, T. P., Kawakawa
Morrin, T., Auckland
Morton, H. B. ,,
Mueller, G. ,,
Munro, G. C., Clevedon
Murdoch, D. L., Auckland
Murray, T. L., Thames
Nathan, L. D., Auckland
Park, James, F.G.S., Thames
Patterson, G. W. S., Kaikohe
Paul, Rev. J. S., Onehunga
Payton, E. W., Devonport
Peacock, T., Auckland
Petrie, D., F.L.S., Auckland
Philcox, W., Devonport
Pond, J. A., Auckland
Purchas, Rev. A. Guyon, M.R.C.S.E., Auckland
Reed, J. R., Kawakawa
Reid, J., Auckland
Roberton, E., M.D., Auckland
Rose, R., ,,
Russell, James, ,,
Russell, T., London*
Scheidel, Dr., Thames
Scott West, Rev. R. J., Mount Eden
Seddon, W., Rotorua
Seegner, C., Auckland
Shaw, H. ,,
Shrewsbury, H., Parnell
Sinclair, A., Auckland
Smith, A. R. ,,
Smith, H. G. S., Wellington
Smith, S. P., F.R.G.S., Wellington*
Smith, T. H., Auckland
Steel, T., Melbourne
Steele, T. J., Devonport
Stewart, J., C.E., Auckland
Thomas, Prof. A. P. W., F.L.S., Auckland
Thornton, Mrs. D. B., Maungakawa
Tinné, H., London*
Tinné, T. F. S., London
Tubbs, Prof. H. A., Auckland
Upton, J. H., ,,
Urquhart, A. T., Karaka
Wade, H. G., Auckland
Walsh, Rev. P., Waimate
Webster, J., Hokianga
Weetman, S., F.R.G.S., Blenheim*

Wildman, W., Auckland
Will, W. ,,
Williams, T. O., M.D., Thames
Williams, Ven. Archdeacon W. L., Gisborne
Williamson, C., Auckland
Wilson, G., Thames
Wilson, H. M., Warkworth
Wilson, W. S., Auckland
Winks, J., Parnell
Withy, E., Remuera*
Wright, G. W., Auckland.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

[Life-members marked thus *.]

Adams, C. E., B.Sc.
Anderson, J.
Murray-Aynsley, A. C.
Murray-Aynsley, H. P.
Baines, A. C.
Bealey, A. S.
Beaumont, J.
Beckett, T. W. Naylor, F.L.S.
Bickerton, Prof. A. W., F.C.S.
Bishop, F. C. B.
Bishop, R. C.
Blakiston, C. R.
Booth, G. T.
Brown, R.
Carew, W. A.
Chilton, C., B.Sc., F.L.S.*
Clark, D., Templeton
Cook, Prof. C. H. H., M.A.
Craig, D.
Cunningham, P.
Danks, T.
Deans, J.
Denniston, Mr. Justice
Dendy, A., D.Sc.
Dixon, M.
Donald, Y.
Enys, J. D.
Evans, W. P., Ph.D.
Fereday, R. W.
Garsia, Captain
Gray, G., F.C.S.
Hall, Sir John, K.C.M.G.
Hall, T. W.
Hardcastle, J.
Hewlings, S.
Hogben, G., M.A.
Hunt, F. Knight
Hutton, Capt. F. W., F.R.S., F.G.S.*
Jackson, T. H., B.A.
Jennings, Dr. E.
Kinsey, J. J.
Laing, R. M., M.A., B.Sc.
Marshall, P., M.A., B.Sc.
May, H. E.
Meares, Dr. A. L. Devenish
Meeson, J. T., B.A.
Meyrick, E., B.A., F.E.S.
Mollet, T. A.
Page, S.
Palmer, J.
Pitcaithley, G., B.A.
Purnell, C. W.
Pye, W. G., M.A.
Rutherford, C. E., M.A.
Scott, J. L.
Seager, S. Hurst, A.R.I.B.A.
Sparks, W., jun.
Speight, R., M.A., B.Sc.
Symes, W. H., M.D.*
Thomas, Dr. W.
Townsend, J.
Wakefield, C. M., F.L.S., F.E.S.
Webb, H. R., F.R.M.S.
Wilkin, R., jun.
Wilkin, W. Bryce
Wood, W. D.

OTAGO INSTITUTE.

[* Life-members.]

Abel, H. J., Lawrence
Adams, C. W.
Allan, John, Taurima, Greytown
Allen, James, M.A., M.H.R.
Armstrong, F.
Aston, Murray
Barnett, L. E., M.B.
Batchelor, F. C., M.B.
Bathgate, Alexander*
Beal, L. O., jun., C.E.
Belcher, Rev. H., LL.D.
Bell, A. D., Waihemo
Bell, G.
Beverley, A.
Bews, D. J.
Black, Professor J. G., D.Sc.
Brent, D., M.A.*
Brown, F. N.
Brown, T.
Brown, W.
Brown, W., M.B.
Buchanan, N. L.*
Burt, Alexander
Campbell, R.
Chapman, F. R.
Chapman, R.
Chilton, C., D.Sc., F.L.S.
Colquhoun, D., M.D.
Cook, G. L., jun.
Don, J. R., M.A.
Duncan, P.
Dunn, J. D.
Ferguson, H. L., M.D.
Fergusson, A. J.
Fitchett, Very Rev. A. R., M.A.
Fitzgerald, W. S.
Fraser, W., M.H.R.
Fulton, S. W., Melbourne*
Gibbons, Prof. F. B. de M., M.A.
Goyen, P.
Hardy, H. F.
Hastings, D. Harris
Hay, P. S., M.A.
Hay, R., C.E.
Hocken, T. M., M.R.C.S., F.L.S.
Hosking, J. H.
Jackson, Howard, Bluespur
Jeffcoat, F. H., M.B.
Joachim, G.*
Logan, J. K.
Lusk, T. W.
Macdonald, Gordon
Macgregor, W. C.
Mackenzie, T., M.H.R.
Mackenzie, H.
Mackenzie, M. J. Scobie
McKerrow, J.
McLean, J., Redcastle*
McNicol, A.
Melland, E.*
Milne, W. D., LL.B.
Ogston, F., M.D.
Parker, Prof. T. J., D.Sc., F.R.S.
Petrie, D., M.A., Auckland*
Rattray, J.
Reid, D., jun.
Reid, G.
Reynolds, Hon. W. H., M.L.C.
Ritchie, J. M.
Roberts, J., C.M.G.
Roberts, W. S., M.R.C.S.
Russell, G. G.
Sale, Prof. G. S., M.A.
Scott, Prof. J. H., M.D.
Shacklock, J.
Shand, Prof. J., LL.D.
Shennan, Watson, Conical Hills
Sidey, J.
Sievwright, B.
Simmers, G. A., M.A.
Sise, G. L.
Skey, H.
Smith, A. Lee

Smith, James
Smith, W. C.
Smith, W., M.B.
Spence, E. J.
Stewart, A.
Stewart, Hon. W. D., M.L.C.
Stout, Hon. Sir R., K.C.M.G., M.H.R., Wellington
Taylor, W.
Tennant, J. E.
Thomson, J. C.
Thomson, G. M., F.L.S.*
Ulrich, Prof. G. H. F., F.G.S.
Wales, N. Y. A.
White, John
White, D. R., M.A.
Williams, H.
Williams, Mr. Justice J. S.*
Wilson, A., M.A.
Wilson, Annette.

WESTLAND INSTITUTE.

Addison, Miss
Arrow, W. H.
Barron, D.
Barton, C. A.
Batten, Miss
Bignell, Captain
Boys, J.
Broughton, F. W.
Campbell, J.
Chesney, J.
Churches, J.
Clarke, J. J.
Cresswell, A. E.
Croft, T. O. W.
Douglas, Rev. William
Duncan, William
Fendall, Miss
Folley, W.
Fowler, W. L.
Gill, T. H.
Glass, H.
Harper, J.
Heinz, W.
Holmes, J.
Jack, M. L. W.
Kendall, Dr. H. W. M.
King, A. H.
Lewis, J. B.
Little, A.
Lynch, J. D.
Macandrew, Dr.
Macfarlane, D.
Macfarlane, Mrs.
Mackay, W. D.
Mahan, A.
Mandle, J.
Martin, Rev. Canon
Maunders, J.
Michel, H. L.
Morton, A. J.
Murray, W. G.
Myles, Dr.
Nightingale, A.
Northcroft, L.
O'Brien, B. L.
Park, J.
Paul, Miss
Perry, W.
Rickards, S.
Roberts, G. J.
Robinson, H. L.
Ross, R.
Sammons, E. B.
Sinclair, G. K.
Sinclair, G.
Snow, H. L.
Solomon, Miss
Tait, Miss
Wade, R. W.
Williams, Captain
Williams, W.
Winchester, W.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

[* Life-members. † Honorary life-member.]

Beamish, N. E., Hastings
Bernau, Dr.
Bibby, E., jun., Waipawa
Birch, W. J., Erehwon
Binsfield, Rev. Father
Bridges, G. G.
Brown, J. H., Whakaki
Burnett, H., Woodville
Campbell, Hugh, Poukawa
Canning, Charles
Carlile, J. W., M.A.
Chambers, J. B., Te Mata
Chambers, J., jun., Mokopeka
Chambers, W. K., Poverty Bay
Coleman, J. H.
Colenso, Rev. W., F.R.S., F.L.S., &c.†
Cooke, J. C., Waipukurau
Cooper, T. R.
Craig, J. W.
Crerar, J.
De Lisle, Dr.
Dinwiddie, W.
Donnelly, G. P., Crissoge
Gilberd, J. G.
Gray, W., B.A.
Hallett, T.
Hamilton, A., Dunedin*
Harding, J., sen., Mount Vernon
Harding, R., Mount Vernon
Hardy, James
Hill, H., B.A., F.G.S.
Holder, H. R., Woodville
Hovell, Very Rev. De B., Dean of Waiapu
Humphries, T.
Jarvis, Dr.
Kettle, N.
Kidd, H. L., B.Sc.
Large, J. S.
Large, H.
Lessong, L., C.E.
Loughnan, I. H., Tukituki
Luff, A., Wellington
Manisty, R., Woodville
Matthews, Miss
McLean, P. S.
McLean, R. D. D.
Meinertzhagen, F. H., England*
Milne-Thomson, Dr.
Mirbach, Dr. R. von, Waipawa
Monckton, W. G., M.A.
Moore, Dr. T. C.
Moore, T. R., Waimarama
Nelson, William, Tomoan
Newton, T. K.
Olsen, —., Norsewood
Ormond, G., Mahia
Ormond, Hon. J. D., M.L.C.
Owen, H.
Paterson, Rev. J. G.
Pinckney, H. H., B.A.
Pitcaithley, G., B.A.
Ringland, J.
Russell, Captain W. R., M.H.R.
Smith, H. Guthrie, Tutira
Smith, J. H., Ohrig*
Spencer, Dr. W. I., F.L.S.
Swan, G. H.
Tiffen, H. S.
Tiffen, G. W., Puhatikotiko, Gisborne
Townley, J., Gisborne
Walker, R. T.
Weiss, W. L., Porangahau
White, G.
White, T., Herbertville
Whitelaw, T.
Williams, F. W.
Williams, J. N., Frimley, Hastings
Williams, Rev. S., Te Aute
Williamson, G. W., Waipawa
Yardin, Rev. Father, Woodville
Yates, Dr. L. G., Santa Barbara, California, F.G.S.A., F.L.S.
Younghusband, J.

NELSON PHILOSOPHICAL SOCIETY.

Atkinson, A. S.
Bartel, J. G.
Black, Sidney
Boor, Dr. L.
Browning, J. S.
Chatterton, Rev. F. W.
Cock, H.
Curtis, W. S.
Davies, W.
Fell, C. Y.
Holloway, J.
Hudson, Dr. J.
Huffam, T. B.
Joynt, J. W.
Kingsley, R. I.
Littlejohn, W. S.
Lukins, E.
Mackie, Dr. W.
Mules, Right Rev. C. O., Bishop of Nelson
Richmond, Hon. J. C.
Twistleton, H. L.
Worley, W. F.

LIST OF INSTITUTIONS AND PERSONS

TO WHOM

THIS VOLUME IS PRESENTED BY THE GOVERNORS OF THE NEW ZEALAND INSTITUTE.

His Excellency the Governor, President of the Institute.
Governors of the Institute (eleven).
Honorary Members (thirty).
The Prime Minister.
The Colonial Secretary.
The Colonial Treasurer.
The Minister of Lands.
The Minister for Public Works.
The Postmaster-General.
The Attorney-General.
The Minister of Education.
The Under-Secretary for the Colony.
The Under-Secretary for Lands.
The Legislative Council.
The House of Representatives.
The Colonial Office, London.
The Agent-General, London.
The Imperial Institute.
Messrs. Trübner and Co. (Agents), 57, Ludgate Hill, London.
British Museum Library, London.
British Museum, Natural History Department, South Kensington, London, S.W.
Linnean Society, London.
Royal Society, London.
Royal Geographical Society, London.
Royal Asiatic Society, London.
Royal Society of Literature of the United Kingdom.
Royal Colonial Institute, London.
Royal Statistical Society, London.
Geological Society, London.
Zoological Society, London.
Anthropological Institute of Great Britain and Ireland, London.
Entomological Society, London.
Geological Survey of the United Kingdom, London.
Editor of *Nature*, London.

Geological Magazine, London.
Geological Record, London.
Imperial Institute, London.
Zoological Record, London.
Victoria Institute, London.
Institution of Civil Engineers, London.
Library of Patent Office, London.
Philosophical Society of Leeds, England.
Leeds Geological Association, Meanwood, Leeds.
Literary and Philosophical Society, Liverpool, England.
Biological Society, Liverpool.
Norfolk and Norwich Naturalist Society, Norwich, England.
University Library, Oxford, England.
University Library, Cambridge, England.
School Library Committee, Eton, England.
School Library Committee, Harrow, England.
School Library Committee, Rugby, England.
Natural History Society, Marlborough College, England.
Clifton College, England.
North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne.
Royal Society, Edinburgh.
Royal Botanic Garden Library, Edinburgh.
Geological Society, Edinburgh.
University Library, Edinburgh.
Royal Physical Society, Edinburgh.
Royal College of Physicians, Edinburgh.
Philosophical Society of Glasgow.
Natural History Society, Glasgow.
Royal Irish Academy, Dublin.
Royal Society, Dublin.
Asiatic Society of Bengal, Calcutta.
Geological Survey of India, Calcutta.
Bombay Natural History Society.
Royal Society of New South Wales, Sydney.
Linnean Society of New South Wales, Sydney.
Public Library, Sydney.
Library of Australian Museum, Sydney.
Department of Mines, Sydney.
Engineering Association of New South Wales, Sydney.
University Library, Sydney.
Agricultural Department, Sydney.
Royal Society of Victoria, Melbourne.
Public Library, Melbourne.
University Library, Melbourne.
Geological Survey of Victoria, Melbourne.
Field Naturalists' Club, Melbourne.
Legislative Library, Adelaide.

Royal Society of South Australia, Adelaide.
University Library, Adelaide.
Public Library of Tasmania, Hobart.
Royal Society of Tasmania, Hobart.
Royal Society of Queensland.
Queensland Museum, Brisbane.
Queensland Branch, Geographical Society of Australasia, Brisbane.
Free Public Library, Capetown.
Canadian Institute, Toronto.
Hamilton Association, Canada.
Geological Survey of Canada, Montreal.
Literary and Historical Society of Quebec, Canada East.
Nova-Scotian Institute of Natural Science, Halifax.
Institute of Jamaica, Kingston.
Science College, Imperial University of Japan, Tokyo.
Literature College, Imperial University of Japan, Tokyo.
National Library, Honolulu.
The Colony of Tahiti.
Society of Natural Sciences, Batavia.
Boston Society of Natural History, U.S.A.
Connecticut Academy, New Haven, U.S.A.
Johns Hopkins University, Baltimore, U.S.A.
Academy of Science, Wisconsin, U.S.A.
Natural History Society, New Brunswick.
Smithsonian Institute, Washington, D.C.
Department of Agriculture, Washington.
Geological Survey of U.S. Territory, Washington, D.C.
American Geographical Society, New York.
New York Academy of Sciences.
Second Geological Survey of Pennsylvania.
American Philosophical Society, Philadelphia.
American Institute of Mining Engineers, Philadelphia.
Franklin Institute, Philadelphia.
Academy of Natural Sciences Library, Philadelphia.
Wagner Free Institute of Science of Philadelphia.
Academy of Natural Sciences, Buffalo, State of New York.
Academy of Natural Sciences, San Francisco.
Stanford University, California.
Academy of Natural Sciences, Davenport, Iowa.
Harvard College, Cambridge, Massachusetts.
Director of Library of Missouri Botanical Gardens, St. Louis, Mo.
Natural History Society of New Brunswick, St. John.
Natural History Society of Frankfurt à O.
Royal Society of Literature and Arts of Belgium, Brussels.

Royal Imperial Institute for Meteorology and Earth-Magnetism, Hohe-Warte, Vienna.
Jahrbuch der Kaiserlich-königlichen Geologischen Reichsanstalt, Vienna.
Ornithological Society, Vienna.
Botanical Society of the Province of Brandenburg, Berlin.
Dr. Bastian, Berlin.
Royal Library, Berlin.
Geographical Society, Berlin.
Imperial German Academy of Naturalists, Dresden.
Physico-economic Society of Königsberg, E. Prussia.
Royal Zoological, Anthropological, and Ethnographical Museum, Dresden.
Verein für vaterländische Naturkunde in Würtemberg, Stuttgart.
Society of Geography, Leipzig.
Redaktion des Biologischen Centralblatts, Erlangen.
Biblioteca e dell' Archivio Tecnico del Ministero Córdoba dei Lavori Pubblici, Roma.
R. Accademia dei Lincei, Rome.
Imperial Museum of Florence.
Royal Geographical Society of Italy, Florence.
Orto e Museo Botanico (R. Instituto di Studi Superiori) in Firenze.
Tuscan Natural Science Society, Pisa.
Museum of Zoology and Comparative Anatomy of the Royal University of Turin.
Editor of *Cosmos*, Turin.
Academy of Science, Modena.
Societá Africana d'Italia, Naples.
National Library, Paris.
Société de Géographie, Paris.
Museum of Natural History of France, Paris.
Natural History Museum, Bordeaux.
Natural History Society, Angers.
Naturhistorischer Verein in Bonn.
Die Naturforschende Gesellschaft in Bern.
Imperial Society of Naturalists, Moscow.
Société des Naturalistes, Kreff, Russia.
Société des Sciences de Finlande, Helsingfors.
Royal Academy of Science, Stockholm.
University of Christiania, Norway.
Bergen Museum, Norway.
Royal Danish Academy of Sciences and Literature of Copenhagen.
Natural History Society of Copenhagen.
Dr. Lutkin, Copenhagen.
Natural History Museum of Hamburg.

M. Teyler, Haarlem.
Naturwissenschaftlicher Verein, Bremen.
Academia Nacional de Ciencias de la Republica Argentina.
School of Mines, Rio de Janeiro.
Society of Engineers, Rio de Janeiro.

Libraries and Societies in New Zealand.

Library, Auckland Institute.
Library, Hawke's Bay Philosophical Institute.
Library, Wellington Philosophical Society.
Library, Nelson Philosophical Society.
Library, Westland Institute.
Library, Philosophical Institute of Canterbury.
Library, Otago Institute.
General Assembly Library.
Library, New Zealand Institute.
Library, University College, Auckland.
Library, University College, Christchurch.
Library, University College, Dunedin.
Library, Auckland Museum.
Library, Canterbury Museum.
Library, Otago Museum.
Library, Otago School of Mines.
Library, Thames School of Mines.
Library, Reefton School of Mines.

Publishing Branch.

Editor.
Assistant Editor.
Draughtsman.
Lithographer.
Government Printer.
Photo-lithographer.

INDEX.

AUTHORS.

A.

Atkinson, A. S., 692

B.

Barnes, R. J., 657
Bates, Rev. J., 676
Beckett, T. W. Naylor, 403
Belcher, Rev. Dr., 683, 684
Bickerton, Professor, 538, 545, 558, 681, 682
Brown, Professor F. D., 677
Brown, R., 409, 422
Buller, Sir W. L., 75, 104, 127, 128, 129, 132, 134, 143, 148, 155, 659, 670

C.

Carlile, W. W., 646
Cheeseman, T. F., 674
Cohen, W. P., 281
Colenso, W., 359, 383, 399, 401, 598, 687, 688

D.

Dendy, Professor A., 177, 190, 191, 682

E.

Egerton, Professor, 676
Emery, Professor C., 635
Ewington, F. G., 675

F.

Farquhar, H., 194, 208
Fenton, F. D., 676
Field, H. C., 446, 672

G.

Gascoyne, Major, 671
Gibbons, Professor F. B. de M., 683

H.

Hamilton, A., 228, 232, 559
Hector, Sir J., 284, 292, 655, 664, 670
Hill, H., 451, 476, 478
Hocken, Dr. T. M., 616
Hogben, G., 681
Hudson, Dr., 692
Hudson, G. V., 293, 657
Hulke, C., 654
Humphries, T., 688
Hutton, Captain F. W., 157, 173, 174, 177

I.

Innes, Dr. F. W., 687

K.

Kingsley, R. I., 238, 407, 606
Kirk, H. B., 287
Kirk, T., 318, 327, 330, 341, 349, 353, 354
Krämer, Dr. A., 214

L.

Laing, R. M., 297, 680
Lichfield, A. J., 663

M.

Mackechnie, E. A., 677
Maskell, W. M., 1, 36, 282, 665
McLeod, H. N., 672
Melland, E., 683
Moore, Dr., 688
Mules, Right Rev. C. O., 693

P.

Park, J., 675
Parker, Professor T. Jeffery, 683, 684
Petrie, D., 405

R.

Rutherford, E., 481

S.

Schaw, Major-General, 513, 535, 660
Segar, Professor H. W., 677
Smith, C., 671

T.

Thomas, Professor A. P., 677
Thomson, G. M., 210, 683
Travers, W. T. L., 224
Tregear, E., 579, 593
Tubbs, Professor A., 675

U.

Upton, J. H., 673

W.

Walsh, Rev. P., 610
White, Taylor, 240, 262, 273
Wilkinson, J. R., 680
Withy, E., 673

SUBJECTS.

A.

Algæ of New Zealand, 297
Anaspis, Structure of, 683
Animal Prodigies, 688
Angles and Parallels, Concrete Conception of, 680
Anomia walteri, n.s., 292
Ant, On a New, 635
Apparatus for determining Lines of Force on which Scientific Apparatus is founded, 682
Appendix, 695
Auckland Institute, xviii., 673, 677, 703
Aurora, Description of, 657
Australia, On New *Coccidæ* from, 36
Australian Plants in New Zealand, 401

B.

Baryte, 664
Birds, Anatomy of Flight of, 284
Birds of New Zealand, 104, 127, 128, 129, 132, 134, 177, 273, 660
Botanical Papers, 297
Botanical Specimens, Preparation of, 318
Botany of Lake Waikaremoana, 359

C.

Canterbury Philosophical Institute, xviii., xix., 680, 682, 705
Causation, The Doctrine of, 646
Celmisia, New Forms of, 327
Ceremonial Language, 593
Chatham Islands, Notes from the, 671
Chlorine a Cure for Consumption, 682
Cladoceres of Hauraki Gulf, 214
Cloud, Peculiar, 663
Coccidæ, New Species of, 36
Coccidæ, Synoptical List of, 1
Coating Non-conducting Substances with Metal, 672
Colenso, Rev. W., F.R.S., Portrait presented to, 688
Colobanthus, New Zealand Species of, 354
Colombia, South America, On Ancient Tombs at, 606
Colonial Rarities, On Living, 672
Copepods (Pelagic) of New Zealand, 214
Corals and Coral Islands, 688
Cordiceps robertsii, Note on, 155, 665
Cosmical Bodies, Equilibrium of, 681
Cosmic Impact, 545
Cosmos, Immortality of the, 538
Crustacea from Macquarie Island, 210
Curiosities of Bird-life, 134
Cyanides, On Disposing Affinity and the Constitution of difficultly-decomposable, 681

D.

Daddy-long-legs, On New, 293
Darwin, 677
Darwinism, Illustrations of, 75
Deinacrida, n.s., 145
Dinornis Bones on Surface, Discovery of, 655
Dinornithidæ, Bibliography of, 228
Dinornithidæ, On the Axial Skeleton in, 157
Discothyrea, n.s., 635
Dysporus serrator in Port Nicholson, 660

E.

Earthquakes during 1894, 699
Echinoderms of New Zealand, 194
Elements, Specific Heat of the, 682
Eurycps abrotanifolius, 654
Explosives, 677

F.

Fern-bird, New Species of, 127
Ferns, Growth of, 446
Ferns, On New, 399, 446, 672
Financial Depression, The, 683
Flight of Birds, 284

G.

Gannet in Port Nicholson, 660
Gentians of New Zealand, 330
Geological Papers, 451
Germ-diseases, Method of Cure in, 657
Glacial Epoch explained by Major-General Drayson's Theory, 513, 660
Glacial Period in Hawke's Bay, Notes on, 451
Gold, Appreciation of, 683
Gravitation, Curves of, 681
Greek Madonna, 675
Greenstone, History of a Block of, 598
Grimmia, On the Genus, 409
Gunnera, A New Zealand Species of, 341
Gymnoblastic Hydroids, On New, 208

H.

Hail, 682
Hawke's Bay, Geology of, 451
Hawke's Bay Philosophical Institute, xviii., xx., 687, 690, 708
Hot-springs of Nuhaka, 478
Hydroids, On New Gymnoblastic, 208

I.

Immortality of the Cosmos, 538
Insect-pests, History of War against, 282
Iron, Magnetization of, 481

K.

Kea, On the, 273

L.

Land Nemertine, On a New Zealand, 191
Land Planarians of New Zealand, 177, 682
Land Shells, Distribution of, 224
Land-tenures, Economic Effects of, 673
Language of Ceremony, 593
Letters and Mails in the Olden Time, 687
Light, Peculiar Cases of Reflection of, 535
Lunatics, Treatment of, 675
Lycopodium, On a New, 399

M.

Macquarie Island, A Visit to, 559
Macquarie Island Crustacea, 211
Macquarie Island, New Grasses from, 353
Macropathus, n.s., 147
Magnetization of Iron, 481
Majaqueus æquinoctialis, 177
Maori House at Maketu, Description of, 674
Maori-Polynesian Dictionary, Notes on, 692
Maori Preserved Heads, 610
Maori Remains, Notes on, 148
Megalapteryx, On Feathers of, 232
Megalopolis, Recent Discoveries at, 684
Metal, Coating Non-conducting Substances with, 672
Meteorology of New Zealand, 697, 698
Microseismic Waves, Note on, 681
Mineral Springs, Use of, for ornamenting Stone, 671
Milk-supply of Wellington, 654
Miscellaneous Papers, 481
Moa and its Aliases, On the Bird, 262

Moa-bones discovered on Surface, 655
Moa Footprints, Discovery of, 476
Moa-hunters' Camp, 237
Moa Leg, with Skin, Tendons, and Feathers, 684
Moa, On a Pneumatic Foramen in Femur of, 173
Moa, On Feathers of a, 232
Moas, On the Axial Skeleton in, 157
Molecular Attraction, 682
Money, History of, 673
Mosses of New Zealand, 403, 409, 422
Mus maorium, Notes on, 238
Myths of Observation, 579

N.

Native Plants, New, 349, 405
Natural History, Importance of studying, 693
Nelson, Plants new to, 407
Nelson Philosophical Society, xviii., xxi., 691, 693, 709
Nemertine, On a New Zealand Land, 191
Nesonetta aucklandica, Notes on, 128
Nestor notabilis, 273
New Zealand Institute: Accounts, 640
New Zealand Institute: Honorary Members, 700
New Zealand Institute: Ordinary Members, 701
New Zealand Institute, Governors of, xv.
New Zealand Institute, Incorporated Societies of, xviii.
New Zealand Institute, Officers of, xv.
New Zealand Institute, Rules of, xv.
New Zealand Institute: Report, 639
New Zealand, On the Earliest Literature relating to, 616
Nuhaka Hot-springs, 478

O.

Œstrelata neglecta, Note on, 132
Organic Bodies, A Mode of representing Graphic Constitution of, 682
Organic Compounds, Classification of, 682
Ornithology of New Zealand, 104
Orthotrichum, On the Genus, 422
Otago, Geology of, 664
Otago Institute, xviii., xix., 683, 685, 706
Oyster-culture in New Zealand, 670

P.

Pachyornis, On Pneumatic Foramen in Femur of, 173
Paryphanta hochstetteri, 239, 670
Paryphanta, On Larger Species of, 224
Pelagic Copepods of Hauraki Gulf, 214
Pélé's Hair, 664
Peripatus novæ-zealandiæ, New Variety of, 190
Phænogams, 383
Phalacrocorax colensoi, Notes on, 129
Phalacrocorax onslowi, Notes 129
Planarians, On New Zealand Land, 177, 682
Plants, New, 349, 405
Plants new to Nelson, 407
Poetry an Interpretation of Life, 676
Pond, Eulogy of the late Professor, 673
Proceedings of Incorporated Societies, 643
Protoplasm, Modern Views of, 680

R.

Rats, Nests of, 238
Rats of New Zealand, 240
Reflection of Light, 535
Religion, Comparative, 676
Riley, Dr. C. V., of Washington, 284, 649

S.

Sandwich Islands, On New *Coccidæ* from, 36
Shell, On a New, 292
Shooting-stars and Meteors, 677
Sophocles, Female Characters in Plays of, 683
Southland Institute, xviii., xxi.
Specific Heat of the Elements, 682
Spectacles, 687
Sphenodon, A Newly-hatched, 659
Sphenœacus, New Species of, 127
Sponges of New Zealand, 287

Sterna frontalis in Port Nicholson, 660
Sun's Heat, On an Oversight in Croll's Mode of lengthening the, 558

T.

Tapu, On the Institution of, 148
Tetanus, Bacilli of, 692
Thames Goldfields, Geology of, 675
Tipulæ, New Species of, 293
Tombs of a Prehistoric Race of Colombia, South America, 606
Tuatara, A Newly-hatched, 659

U.

Utick, New Species of, 127

V.

Vanessa itea, 281
Vegetable Caterpillar, Note on the, 155, 665

W.

Waikaremoana, Botany of Lake, 359
Wellington Philosophical Society, xviii., 643, 671, 701
Wellington, Milk-supply of, 654
Westland Institute, xviii., xx., 686, 707
Wetas, Notes on the, 143
Weta, On a New Species of, 174
Worms, Parasitic, in Man, 683

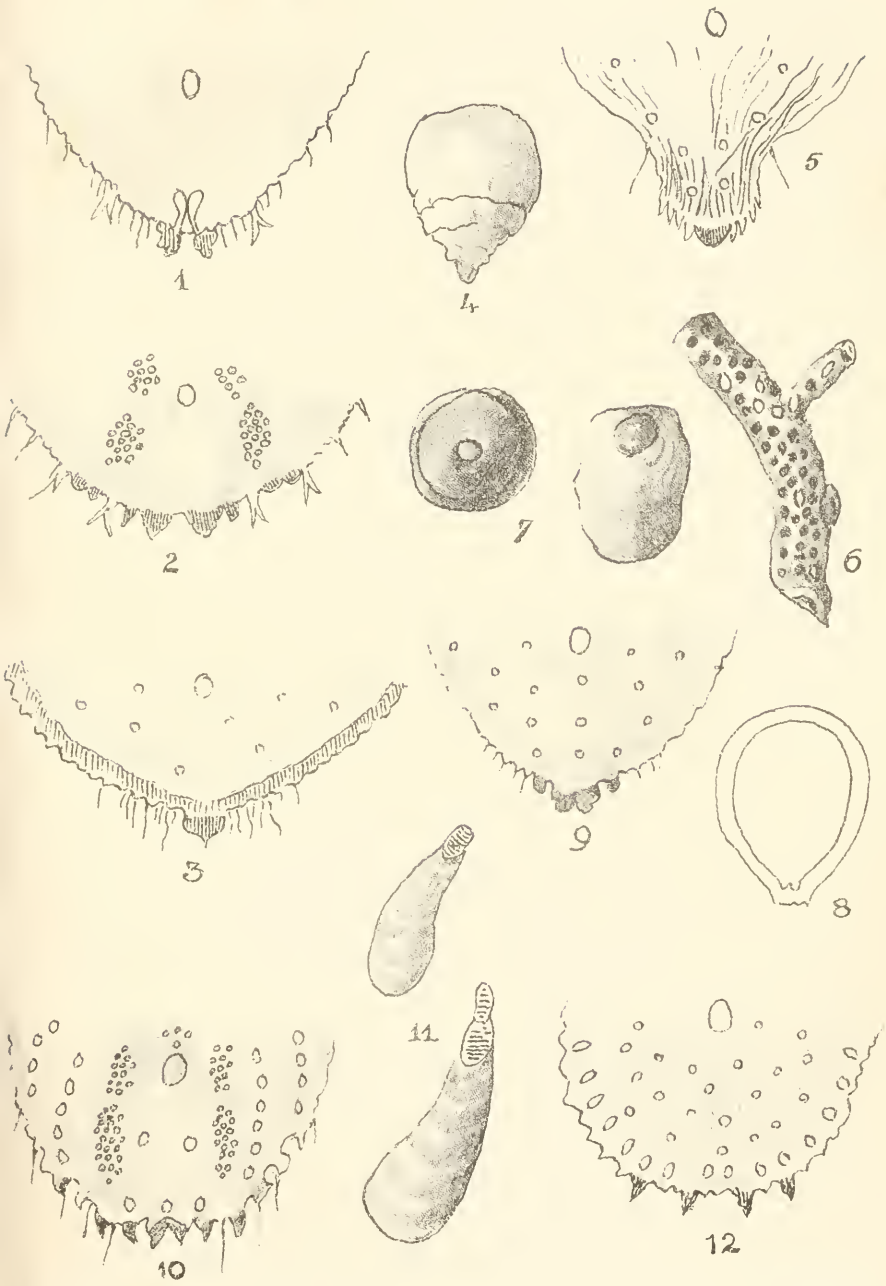
Y.

Yorkshire Blood-feud, 676

Z.

Zoological Papers, 1, 635

SAMUEL COSTALL, Government Printer, Wellington.—1895.

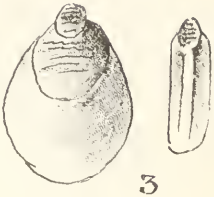


M. M. M. delt. ad nat.

W. de R. B. lith.

1.

2.


3.

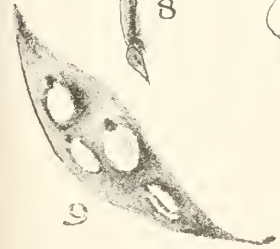
4.

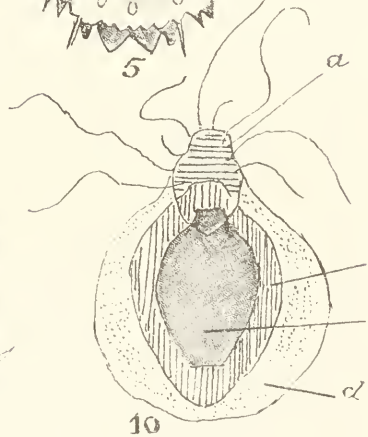
5.

6.

7.

8.


9.



10.

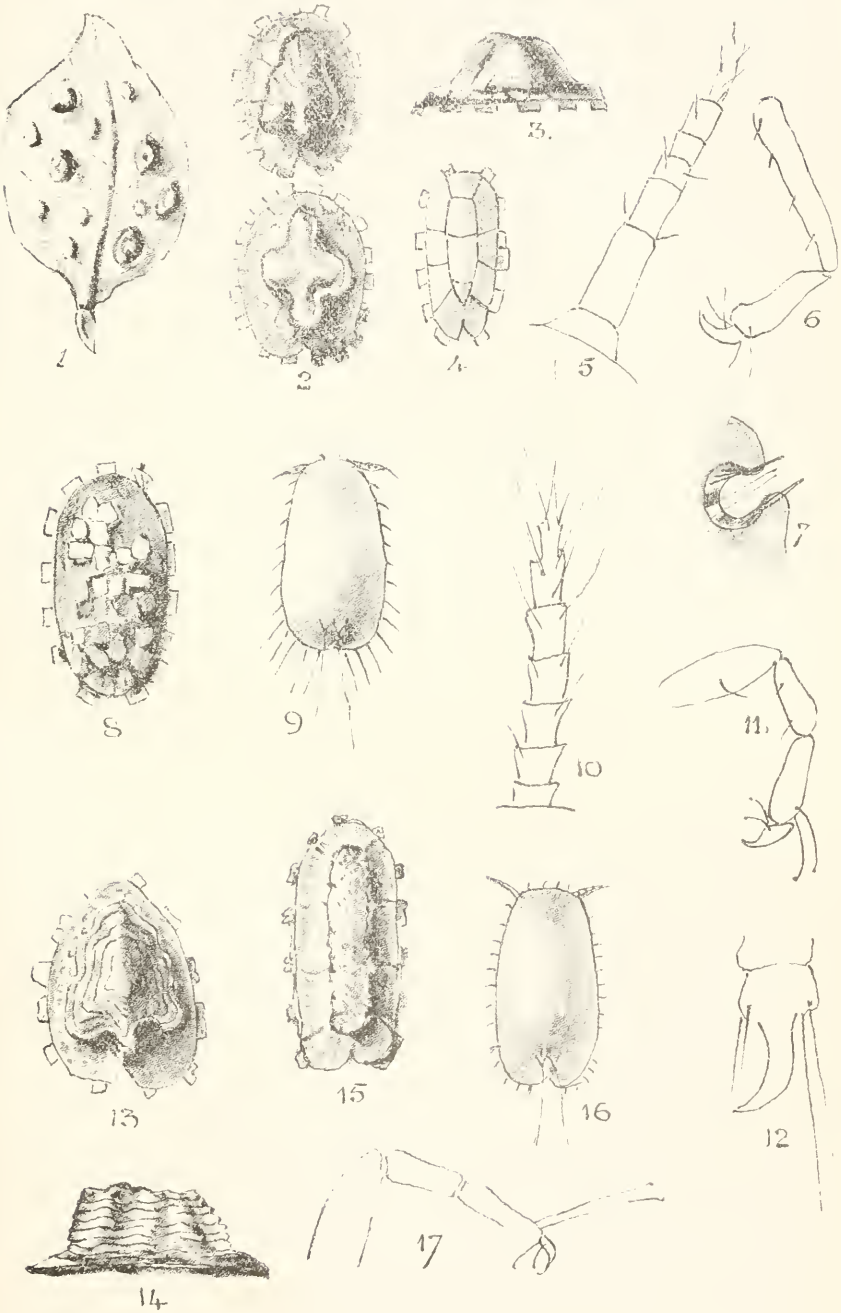
11.

12.

13.

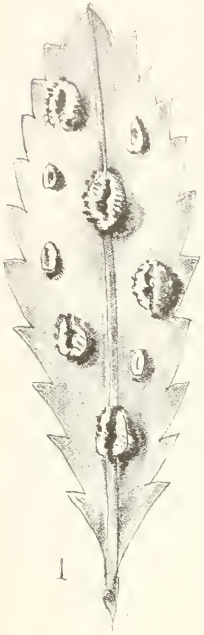
W.M.M. delb ad nat.

Wde R.B. lith.



N.M.M. del. ad nat.

W. de R. B. lith.


1

2

3

4

5

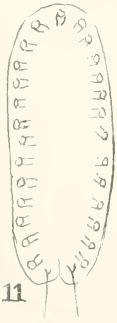
6

7

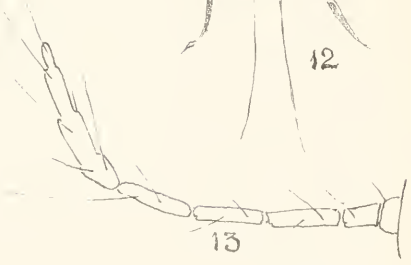
8

9

10

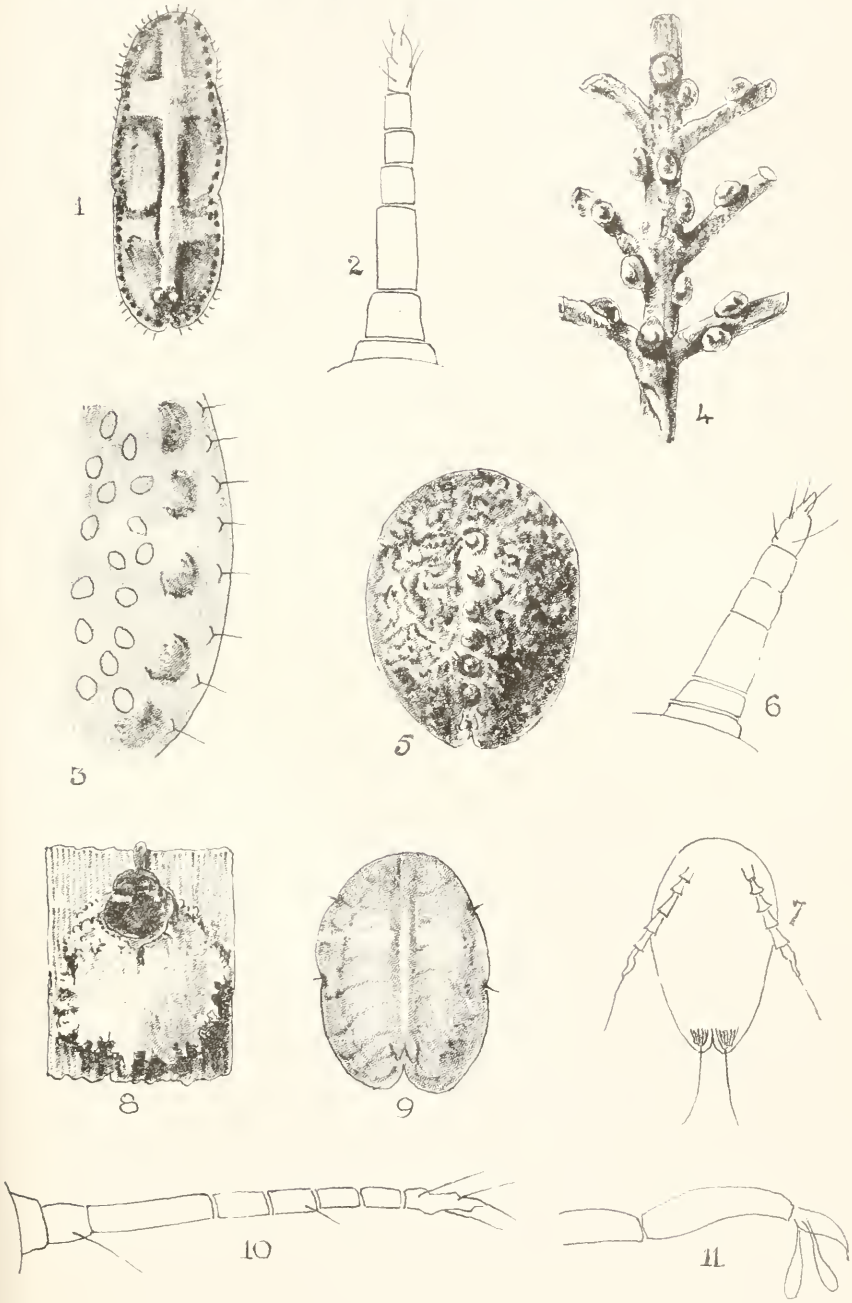

11

12


13

W.M.M. del^r ad nat

W. de R. B. lith

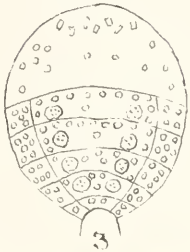


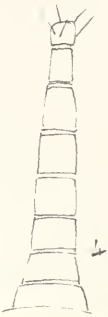
W. M. M. del^t ad nat

W. de R. B. lith.

1

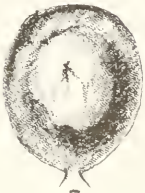
2


3


4

5

6


7

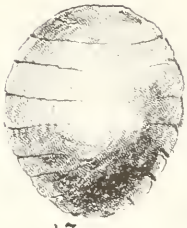
8

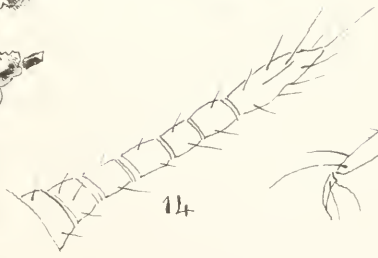
9

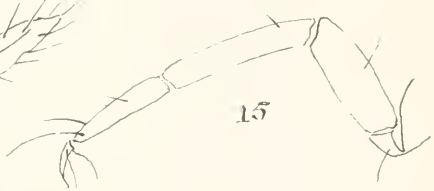
10

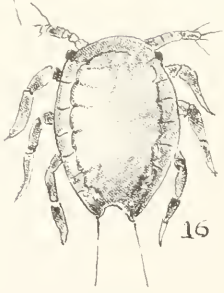
11

12


13


14


15


16

W.M.M. del.t et nat.

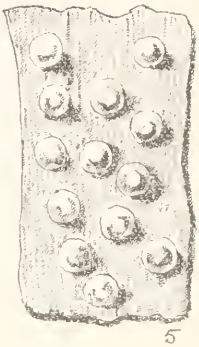
W. de R.B. lith

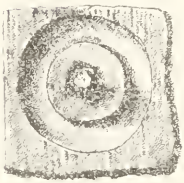
1

2

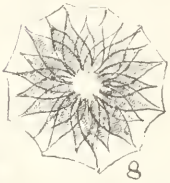
3

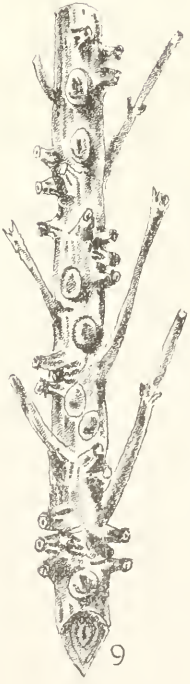
4


5


6

7

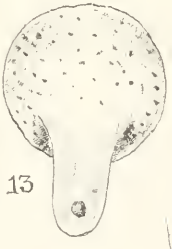

8


9

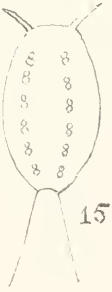
10

11

12


13

14


15

16

17

18

19

W.M.M. delt ad nat.

W. de R.B. lith.

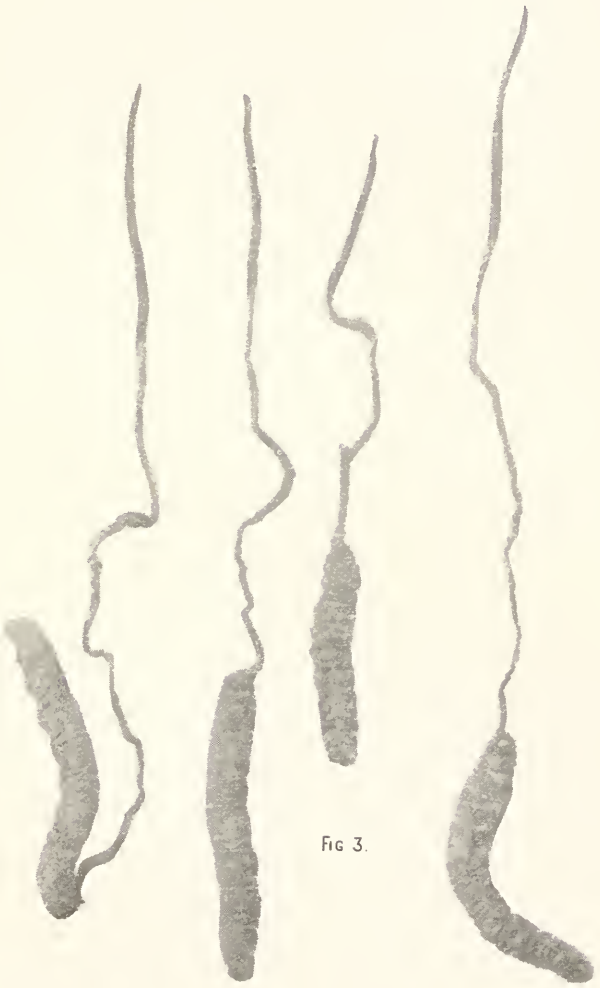


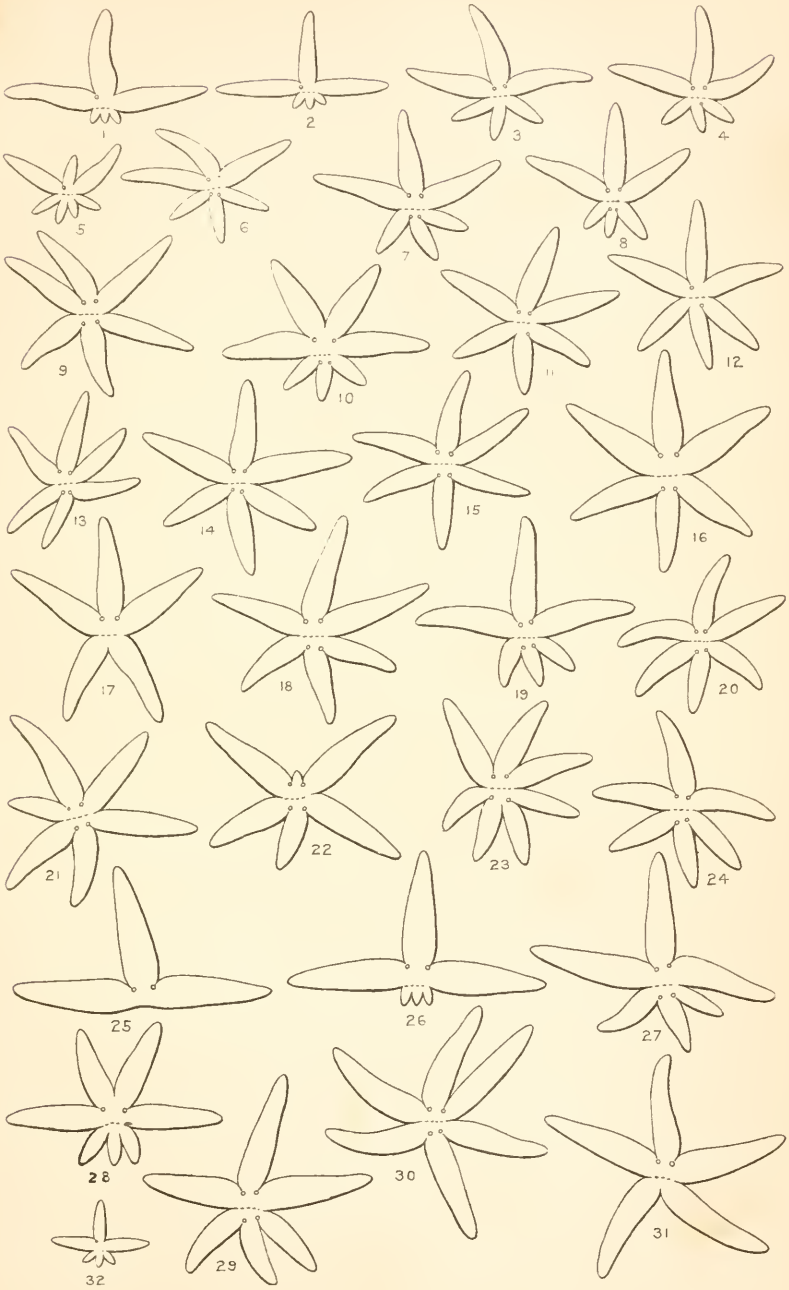
Fig 1.

Fig 2.

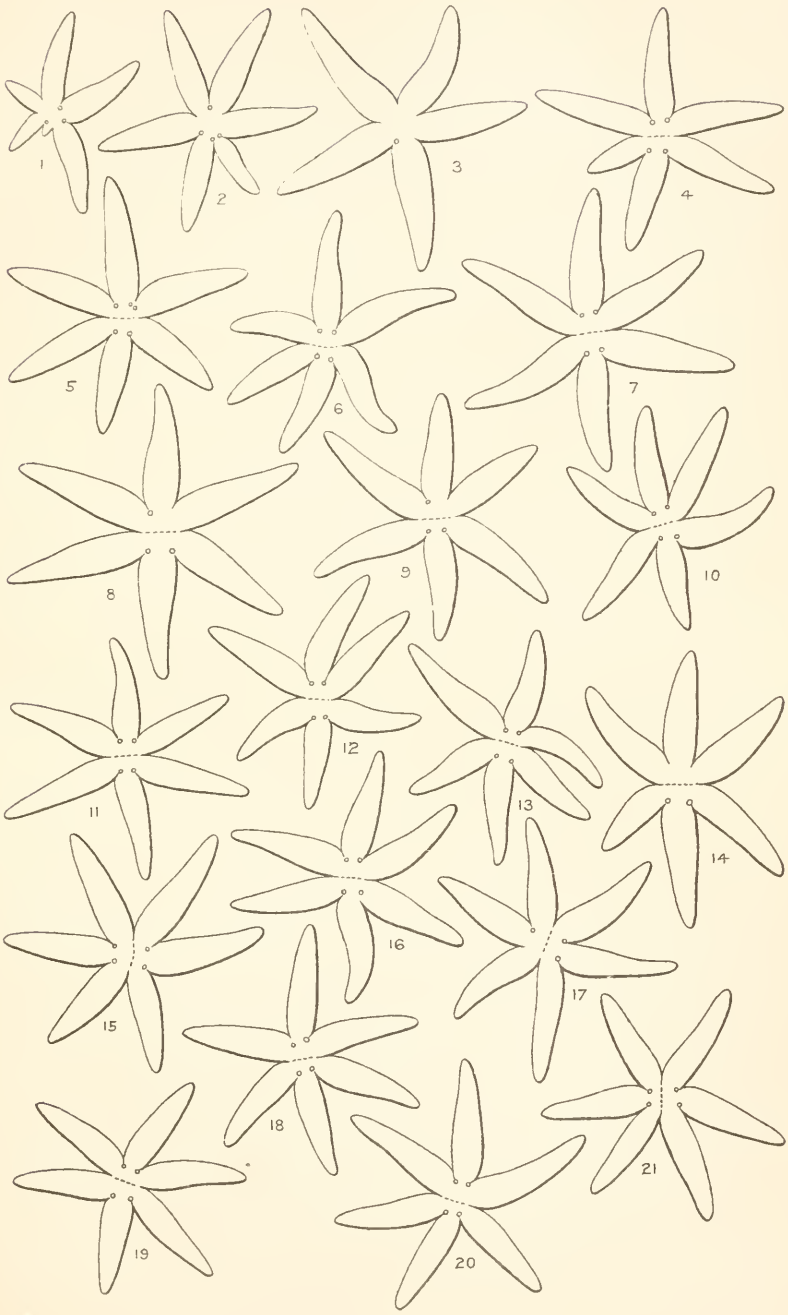
Fig 3.

Fig 4.

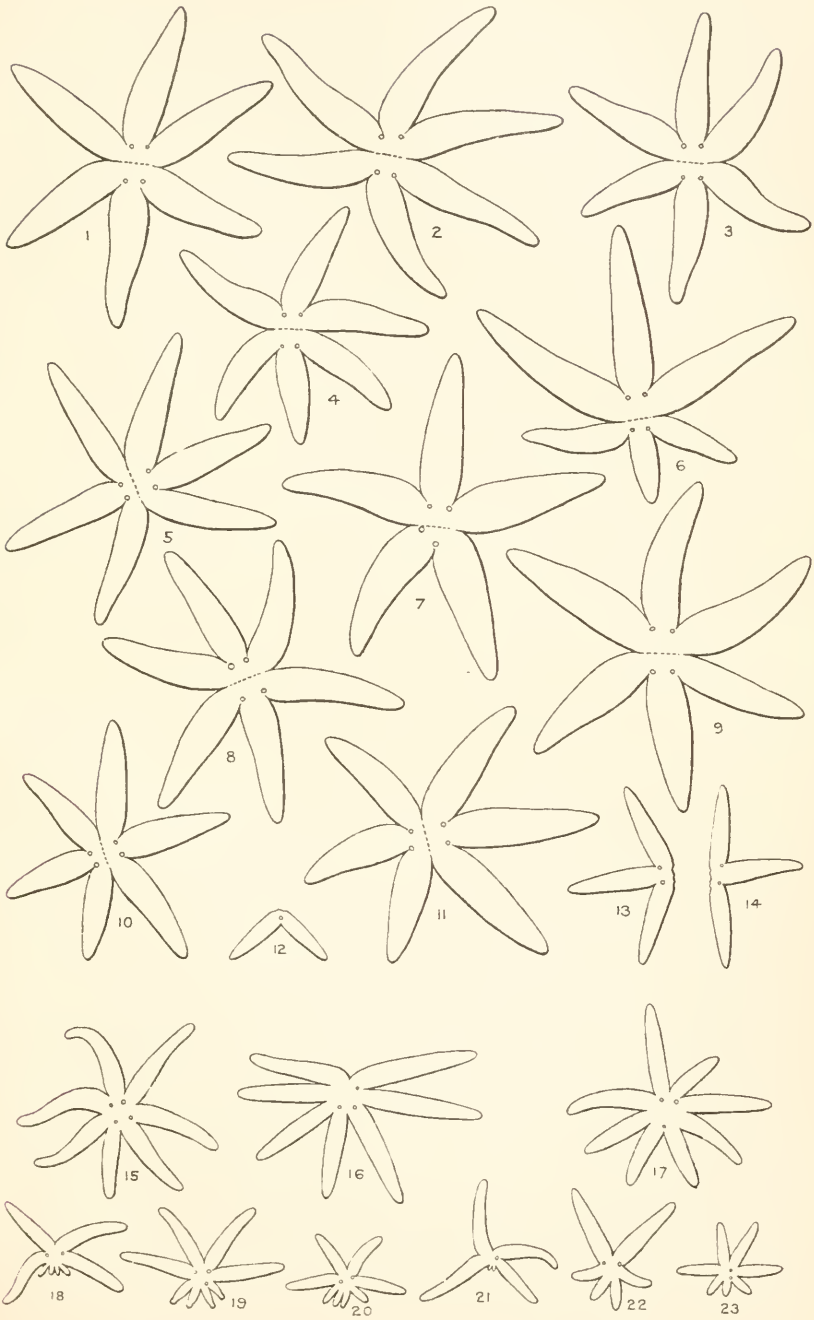
Left femur (size ⅔) of
Pachyornis pygmæus, shewing pneumatic foramen



H.F. STICHASTER INSIGNIS ♀



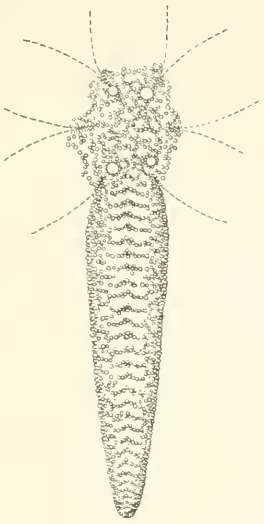
H.F. STICHASTER INSIGNIS ½



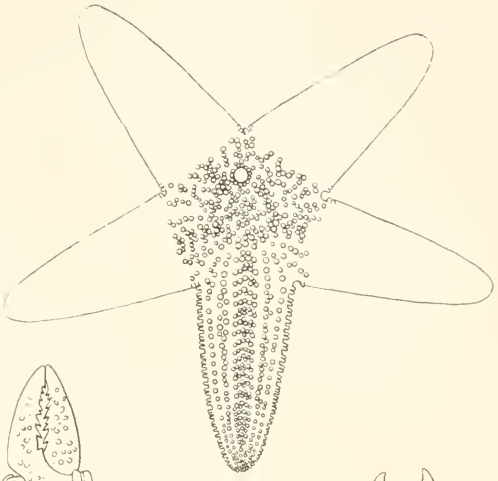
1-14 Stichaster insignis ½

15-23 Tarsaster neozelanicus ½

H.F.



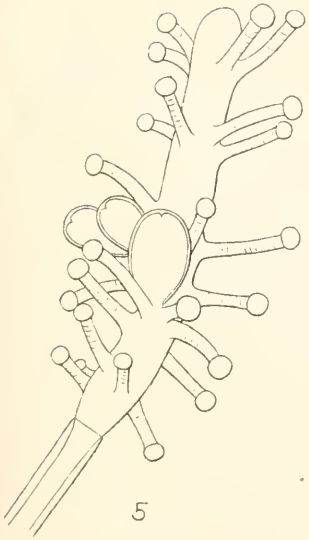
1



2

3

4

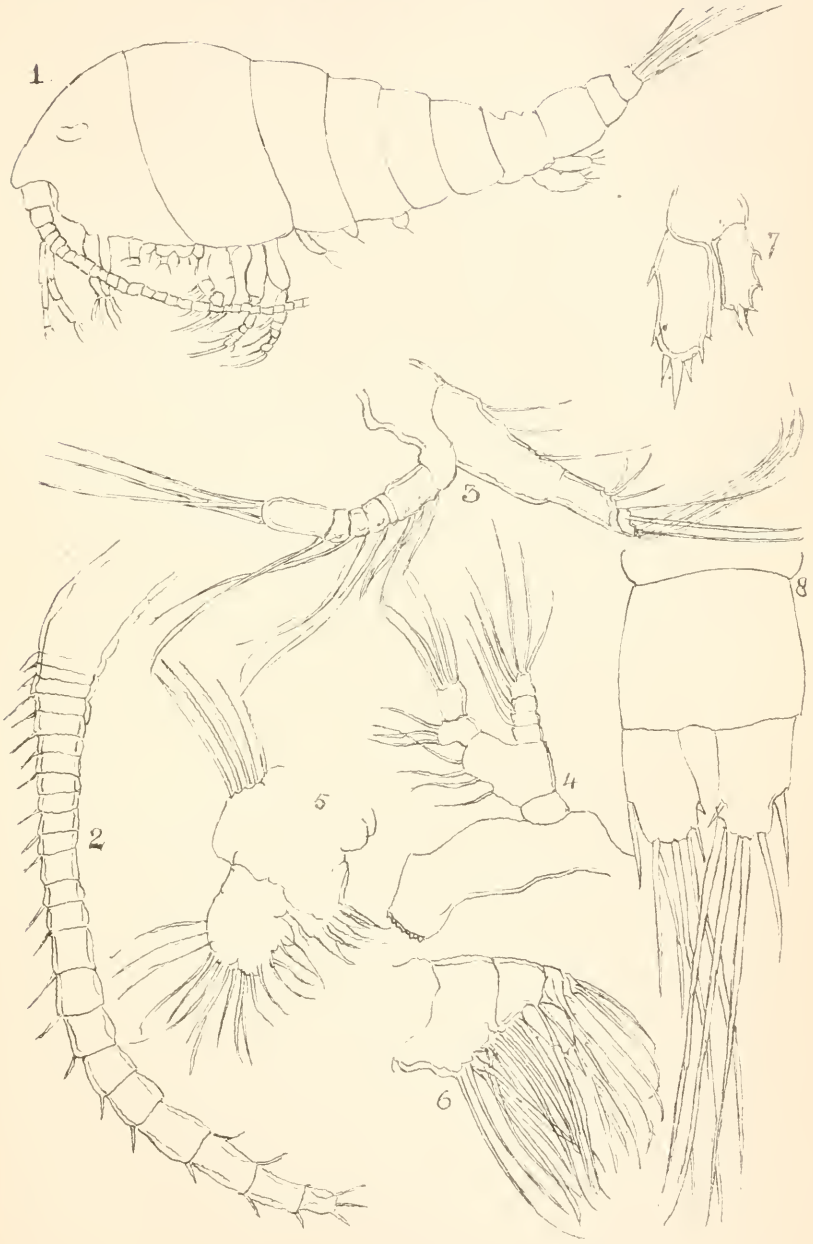


5

6

1. STICHASTER INSIGNIS nat. size
2. STICHASTER LITTORALIS nat. size
3. 4. PEDICELLARIÆ OF ASTERIAS SCABRA
5. CORYNE TENELLA ×36
6. TUBICLAVA RUBRA ×56

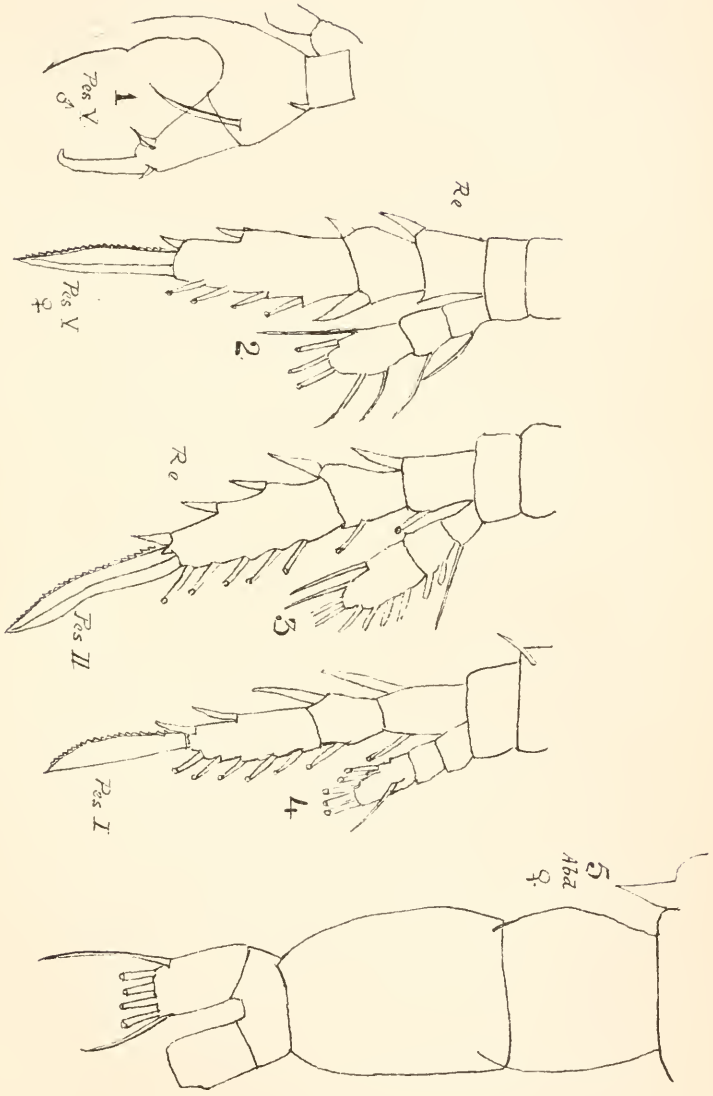
HEK & HF del.



T. del.t

CRUSTACEA.

W. de R. B. lith.



K. del.t

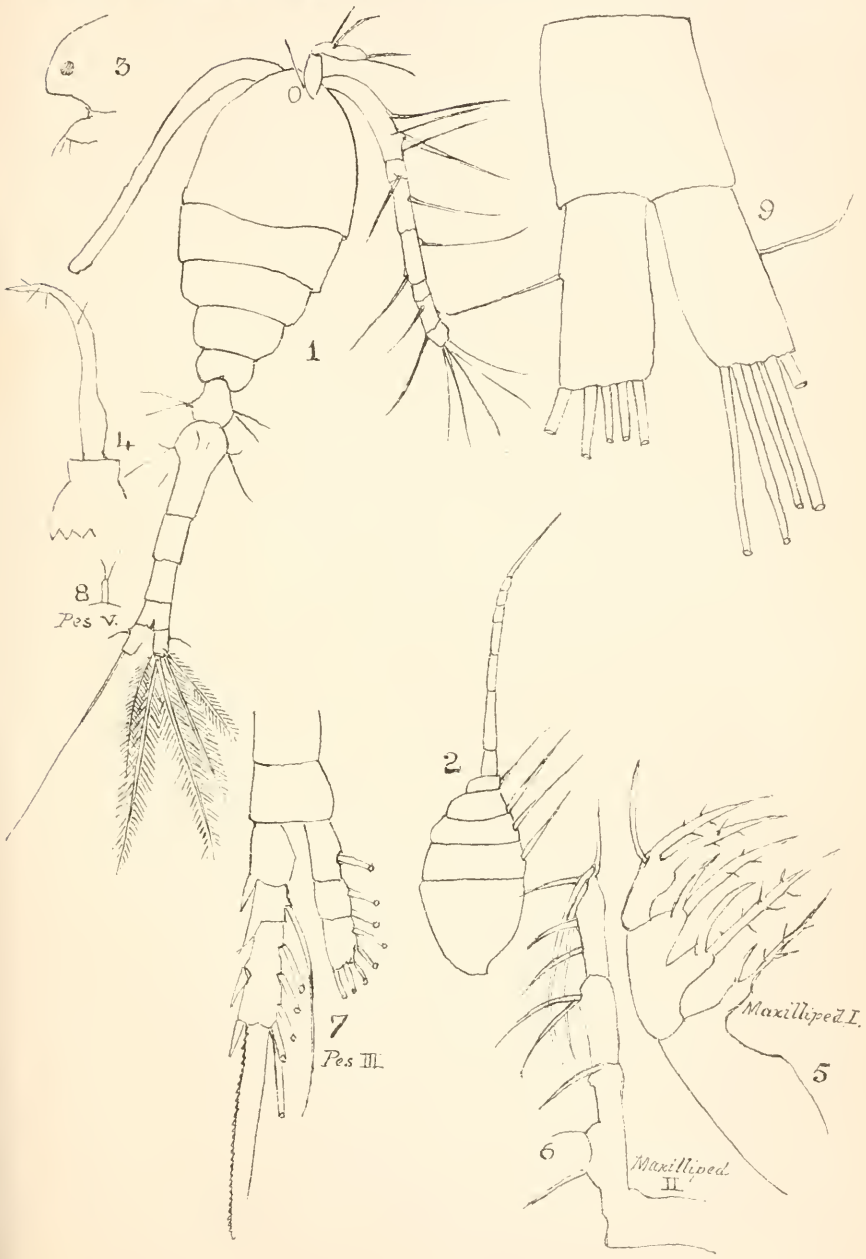
N.Z. COPEPODES

Wade R.B. lith.

K. delt

N.Z. COPEPODES

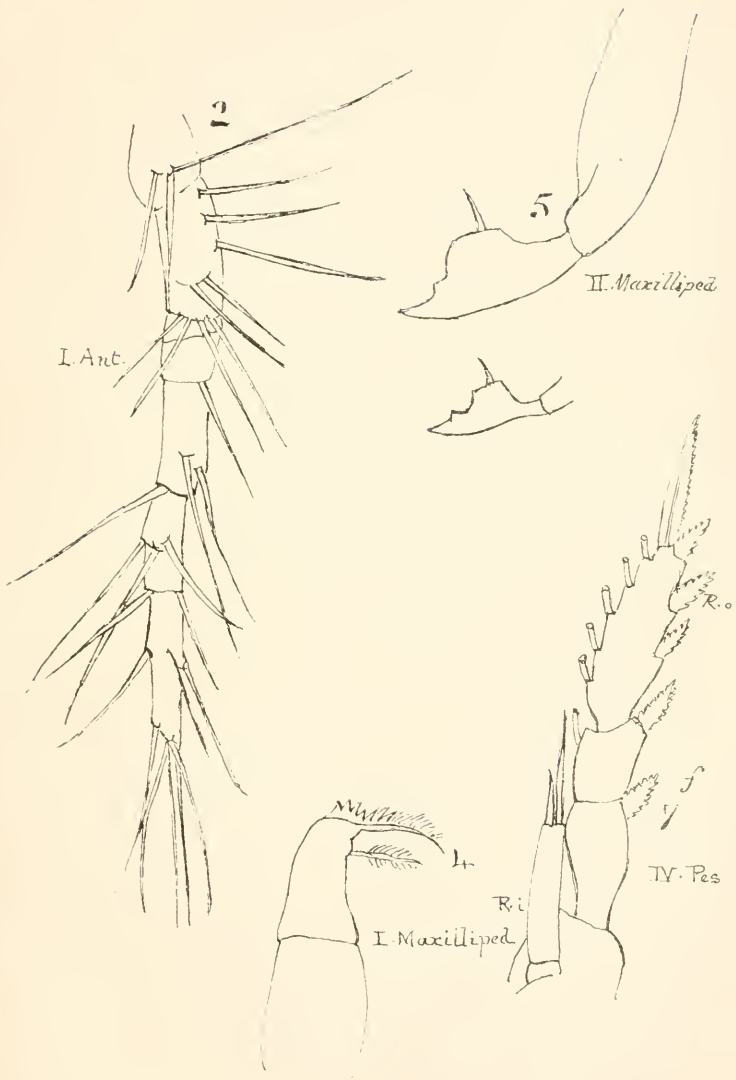
W.de R.B. lith



K. del.t

N.Z. COPEPODES

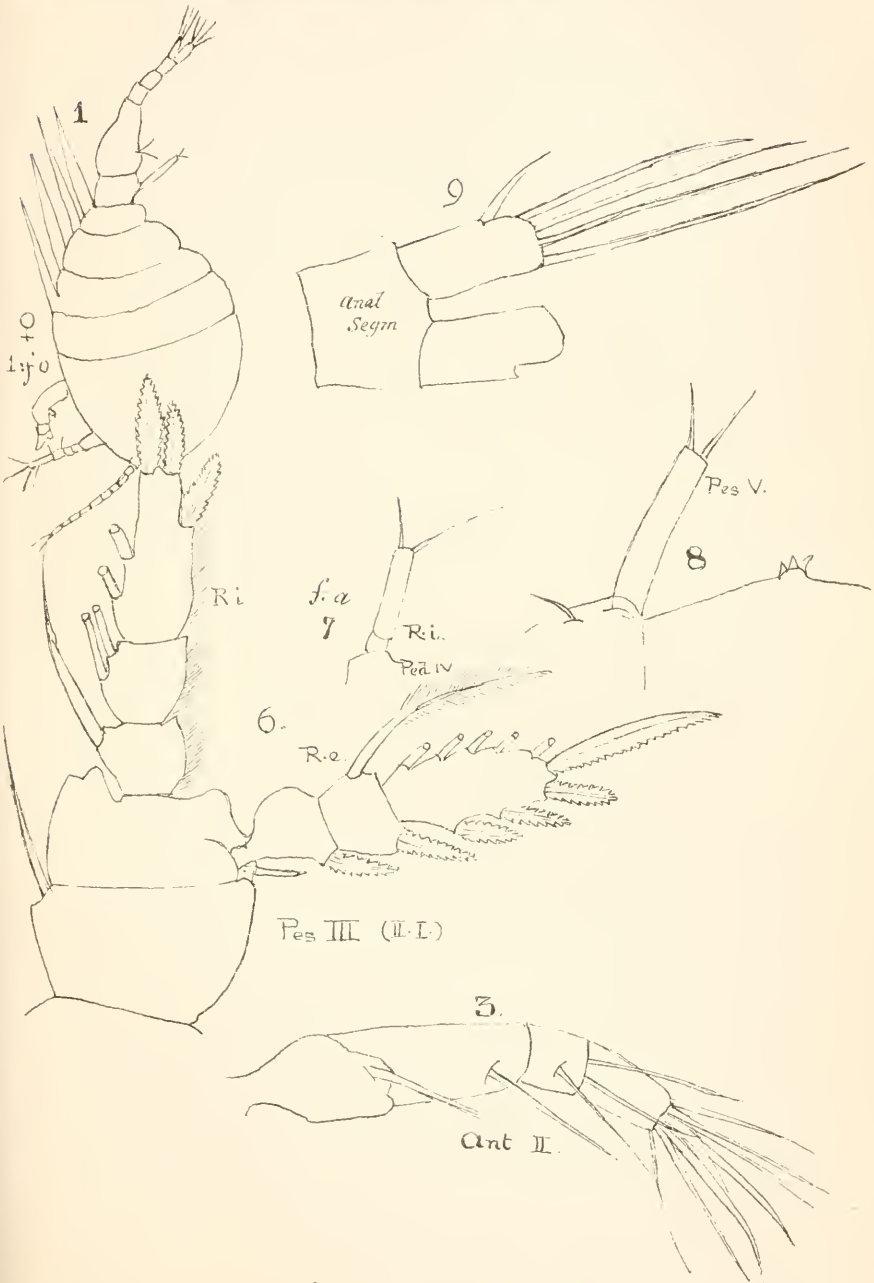
N.de R.B. lith.



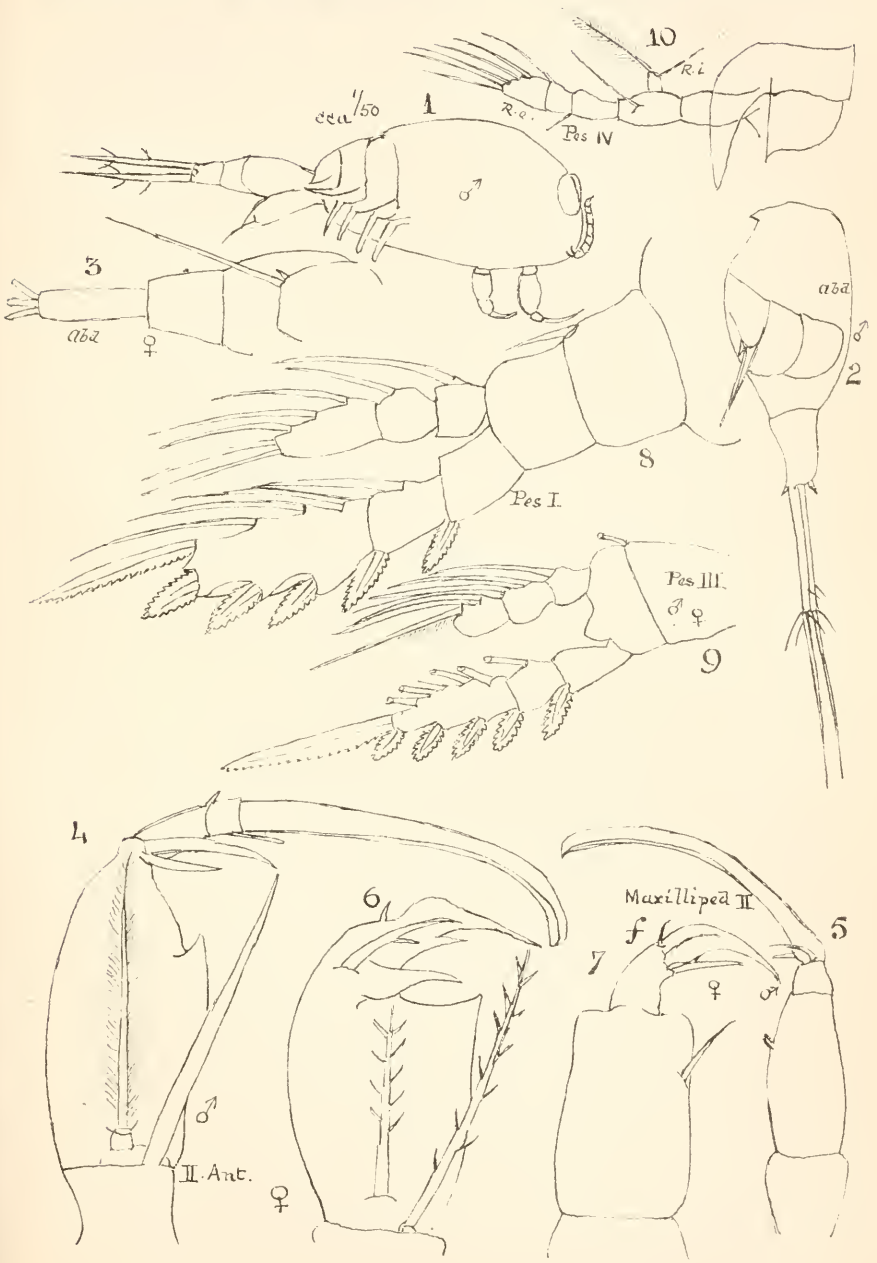
N.Z. COPEPODES.

K. del.

W. de R. B. lith.



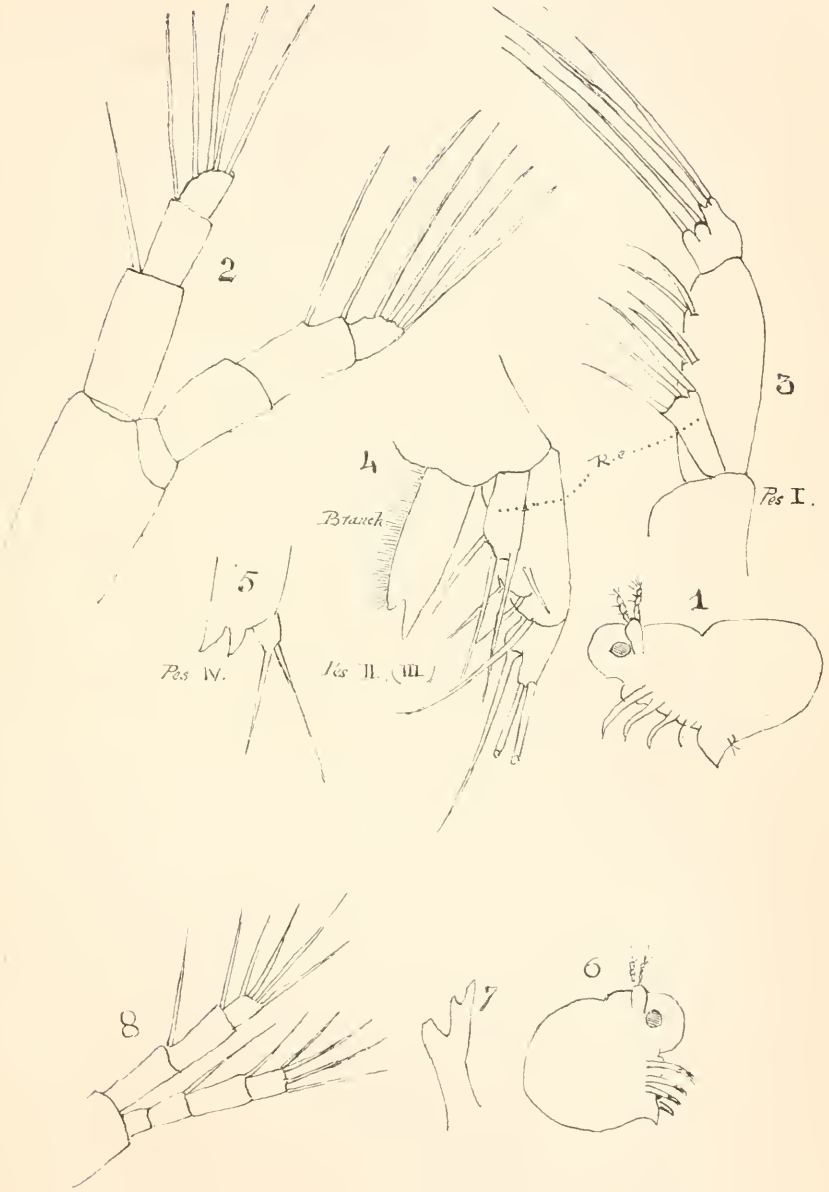
K. del^t N.Z. COPEPODES. W. de R.B. lith.



K. del.

N Z. COPEPODES

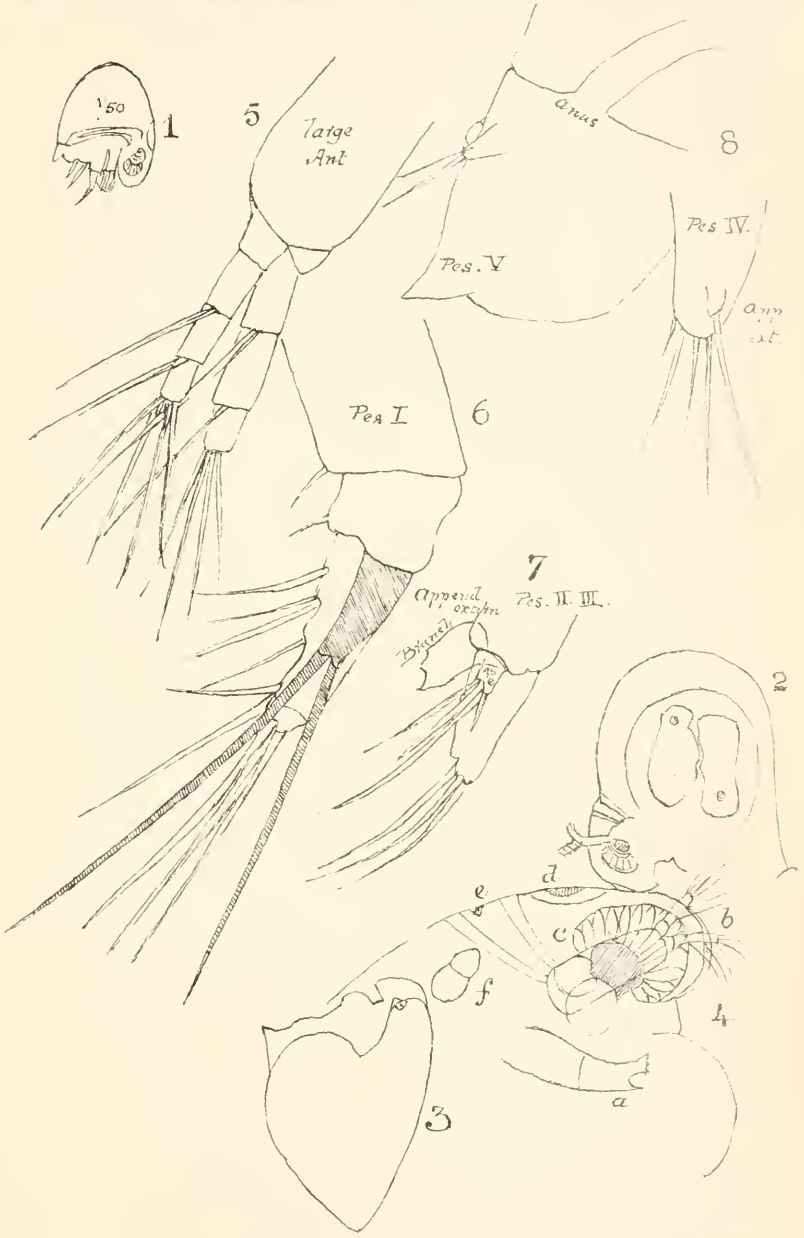
W. de R. B. lith.



K del.

N.Z. CLADOCERES

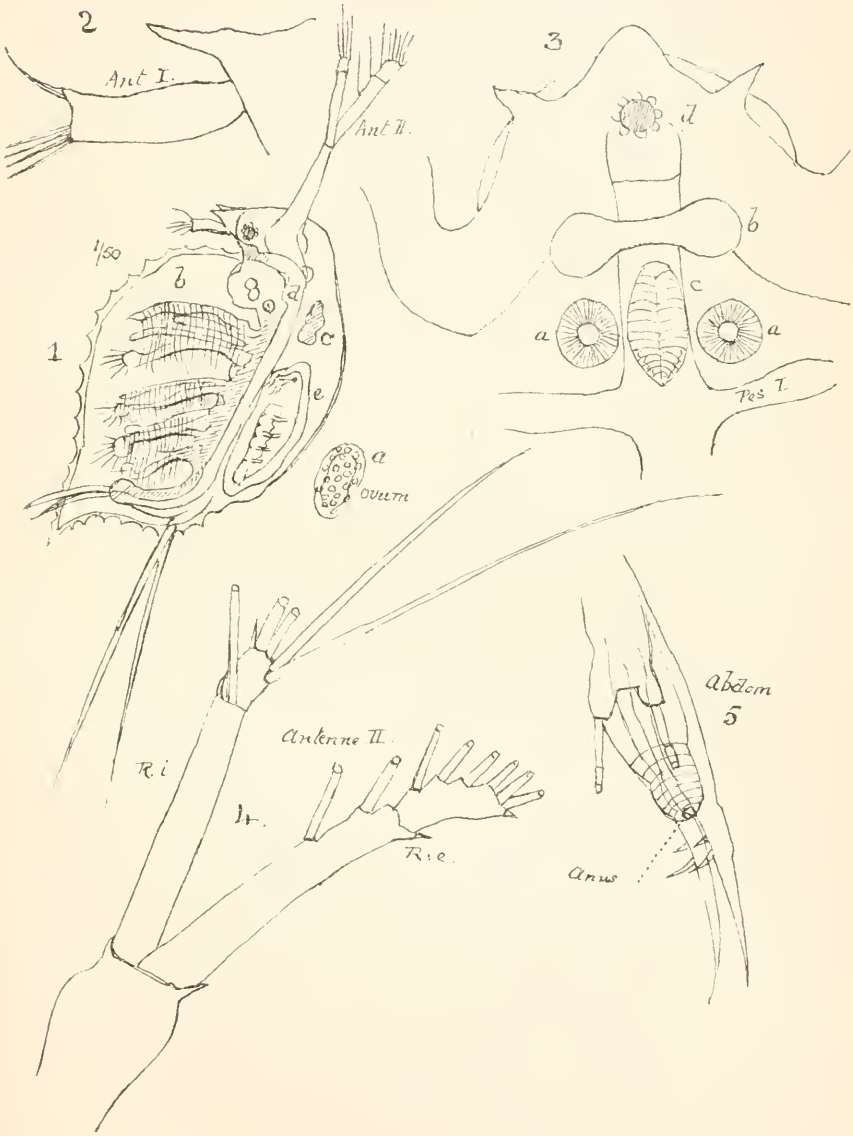
W.doR.B. lith.



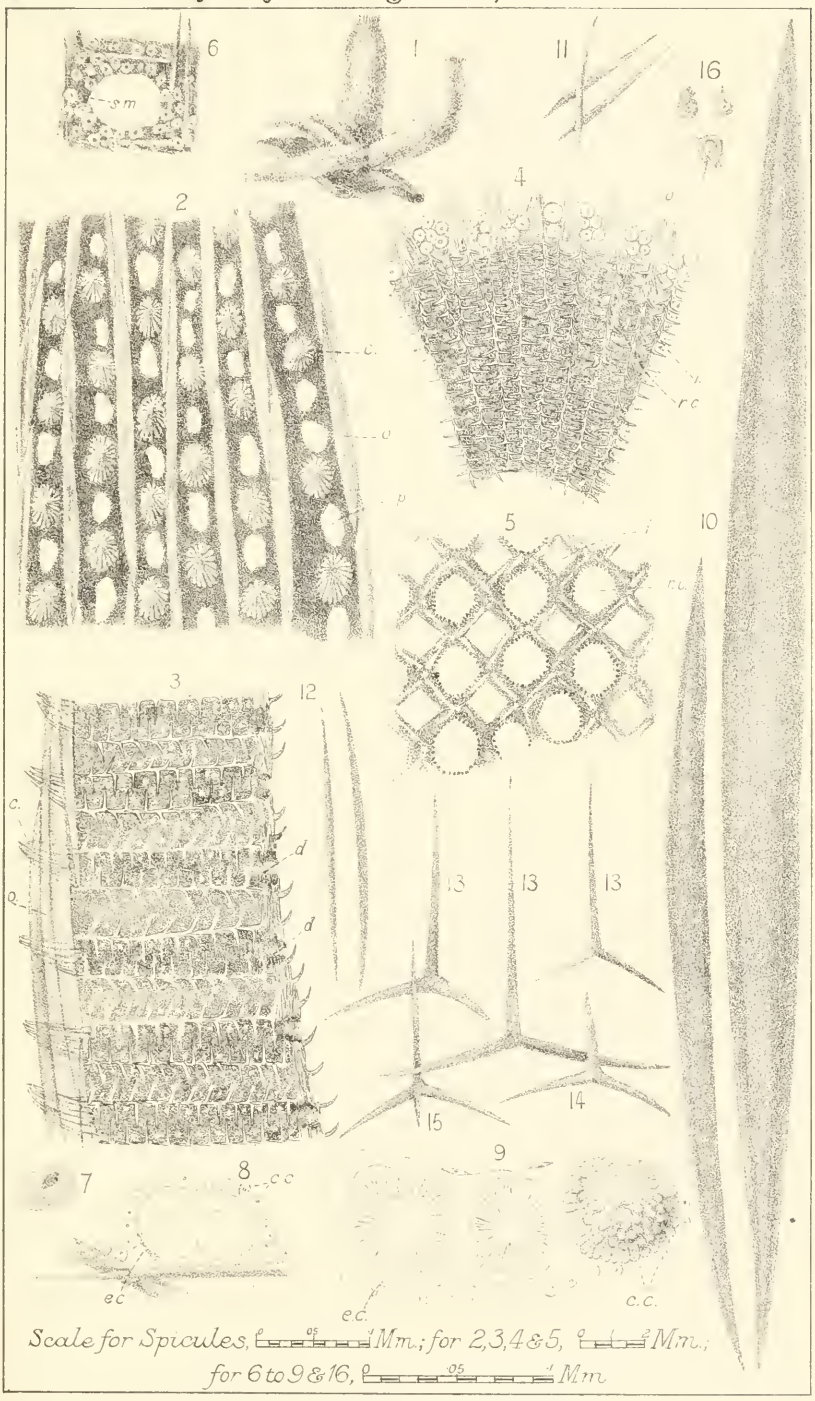
K. delt

N.Z. CLADOCERES

W. deR.B. lith

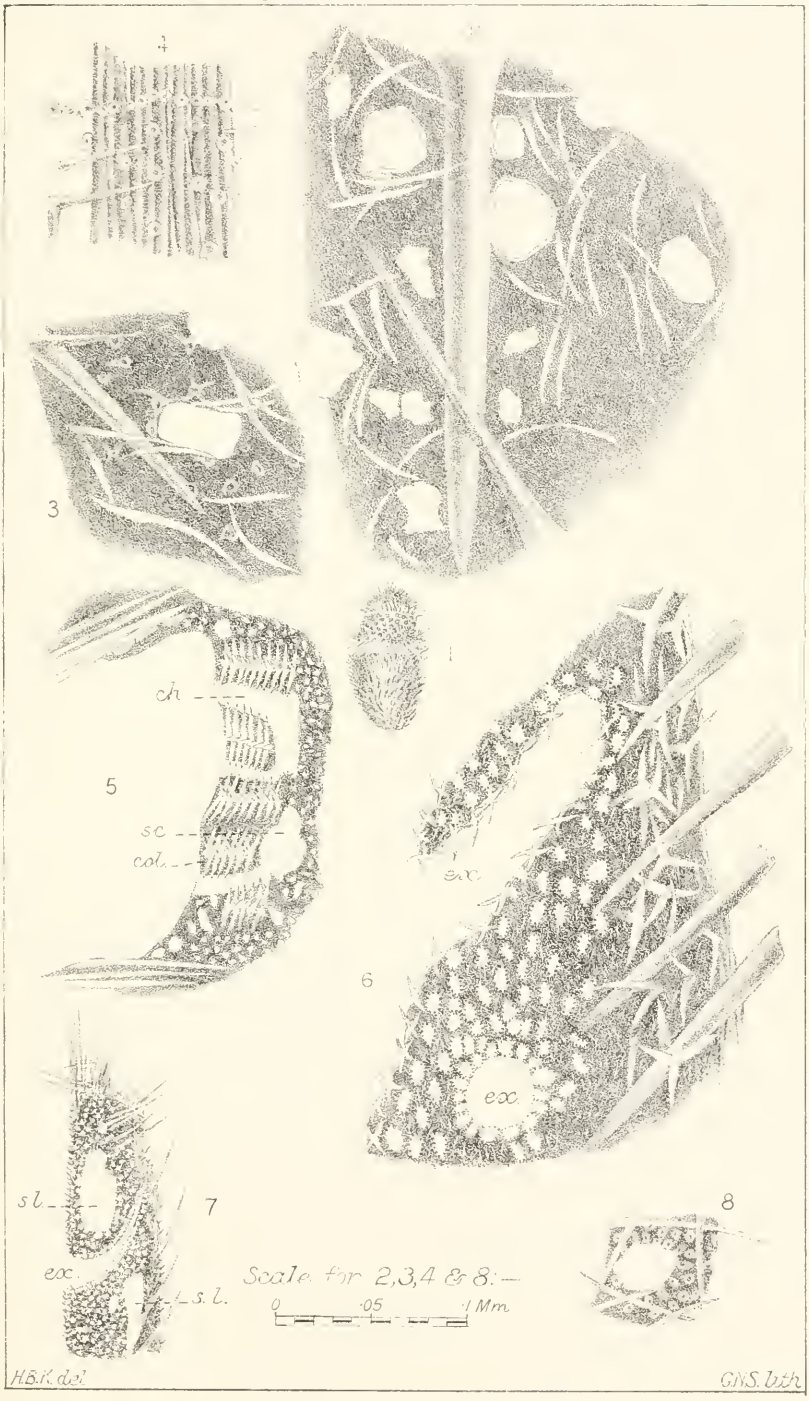


K. del^t N.Z. CLADOCERES. W. de R.B. lith

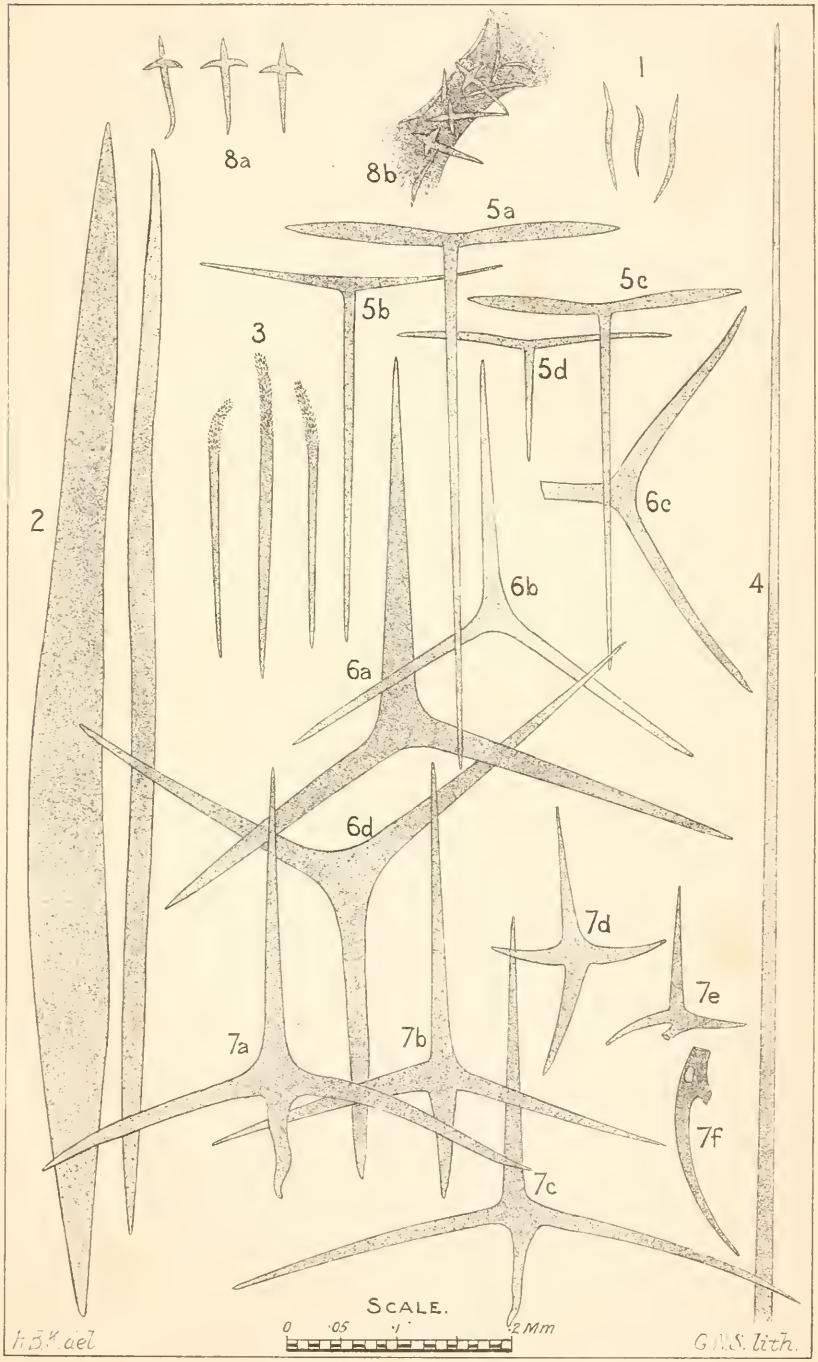


Scale for Spicules, 0 .05 1 Mm.; for 2,3,4 & 5, 0 .1 .2 Mm.; for 6 to 9 & 16, 0 .05 .1 Mm

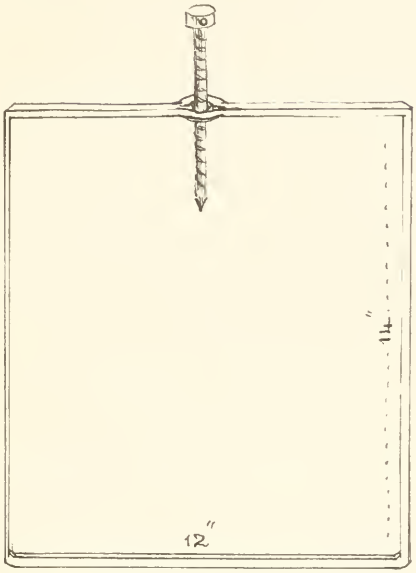
SYCON DENDYI, n sp

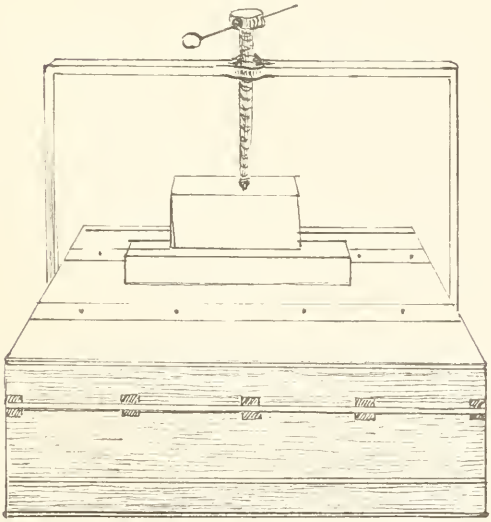


LAMONTIA ZONA, n. sp.



LAMONTIA ZONA n.sp.





BOTANICAL PRESS.

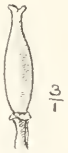
W. de R. B. lith

A.H. del. *Gentiana.* W.deR.B. lith.

W.N.B. del. *Gentiana* W.deR.B. lith.

1

2



3

W.N.B. del. *Gentiana.* W. & R.B. lith.

T. Kirk. *Gentiana* Wade B. lith.

E.C.H. del. COLOBANTHUS n.s. W.deRB. lith.

7

5

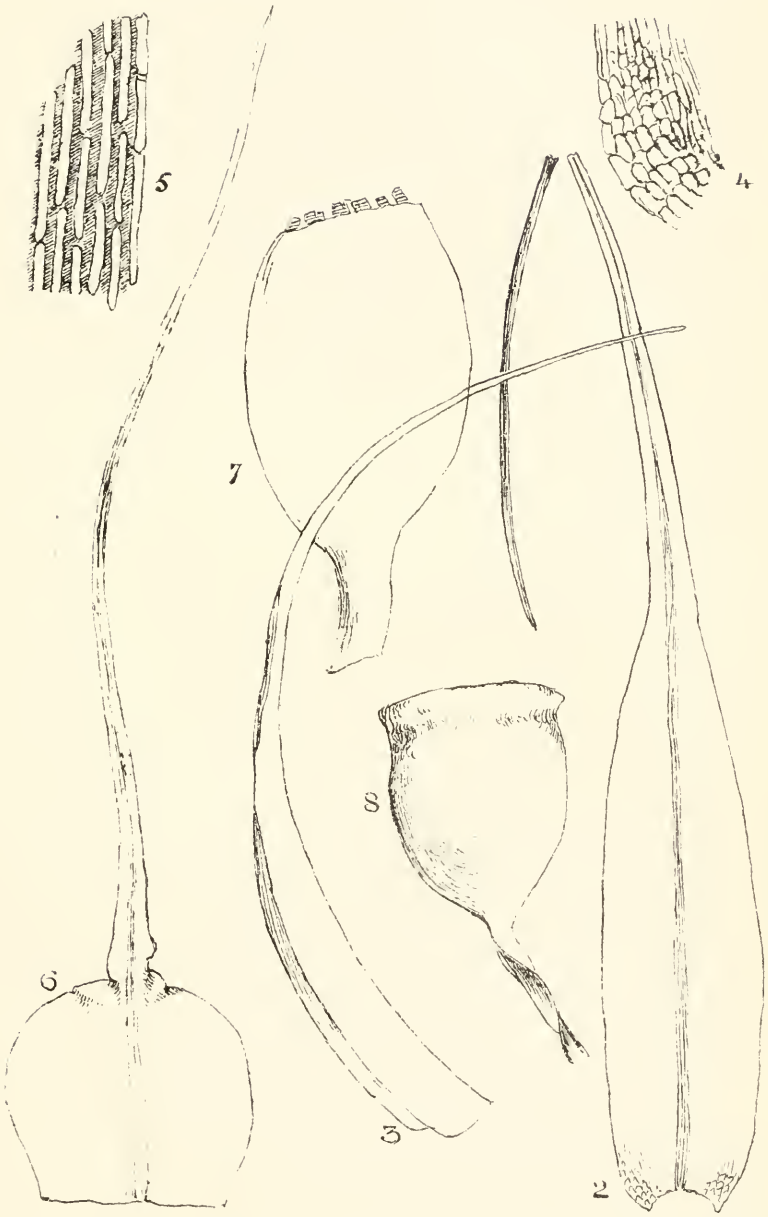
6

4

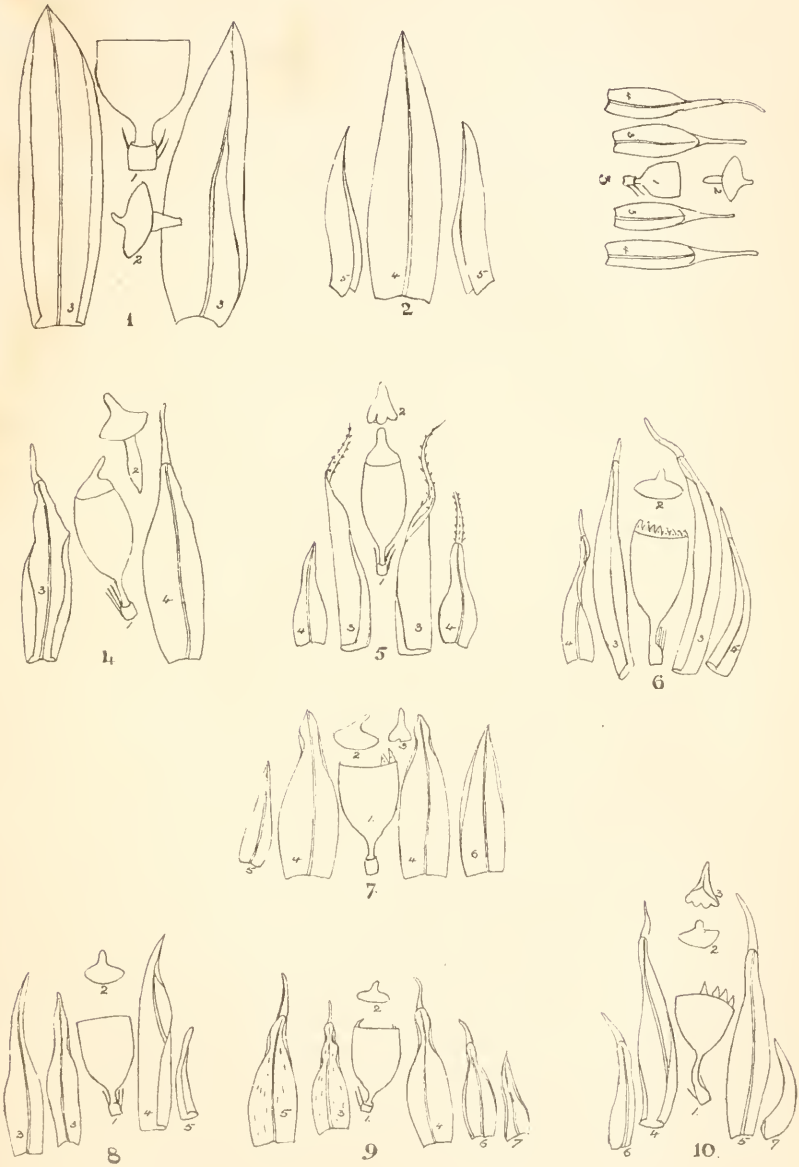
E.C.H. del.

COLOBANTHUS.

W. de R.B. lith.



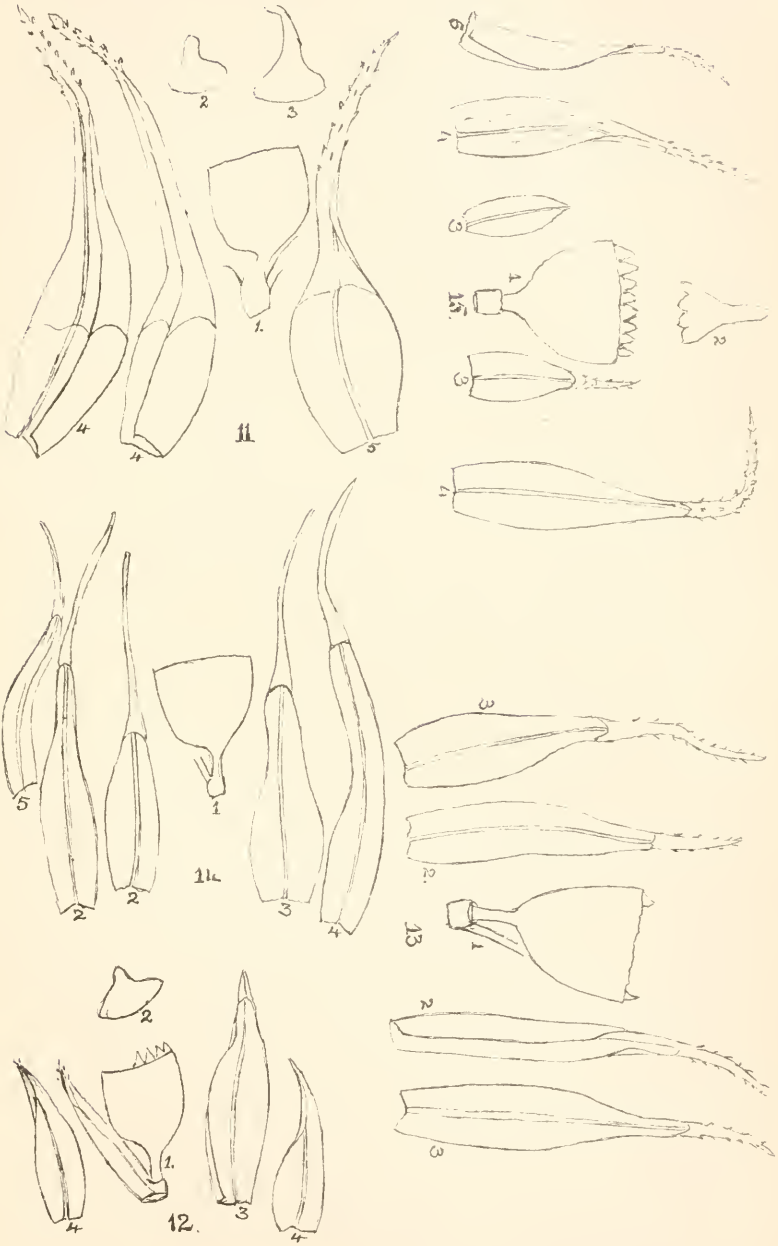
T.W.N.B del. BLINDIA TENUIFOLIA Hf & W W.deR.B. Lith.



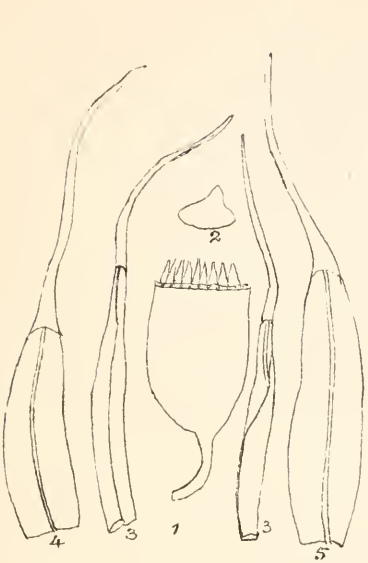
GRIMMIA

R.B. del.t

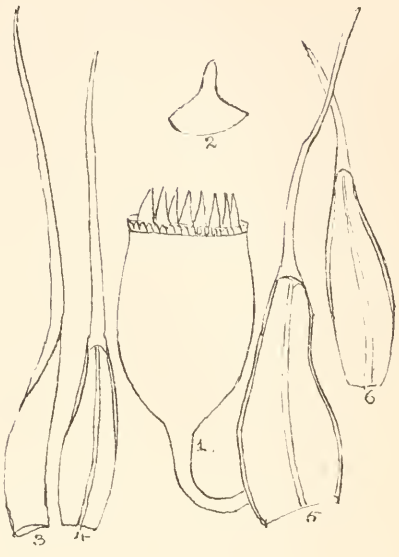
W. de R.B. Tr.Ph.



RB. del.t GRIMMIA WdoRB. lith.

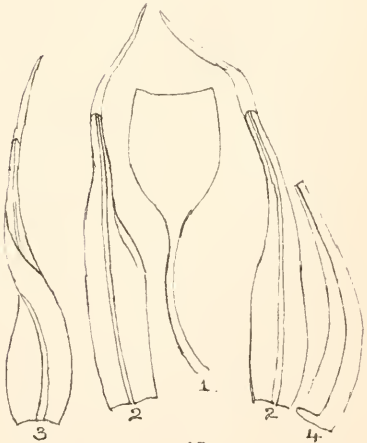


16.



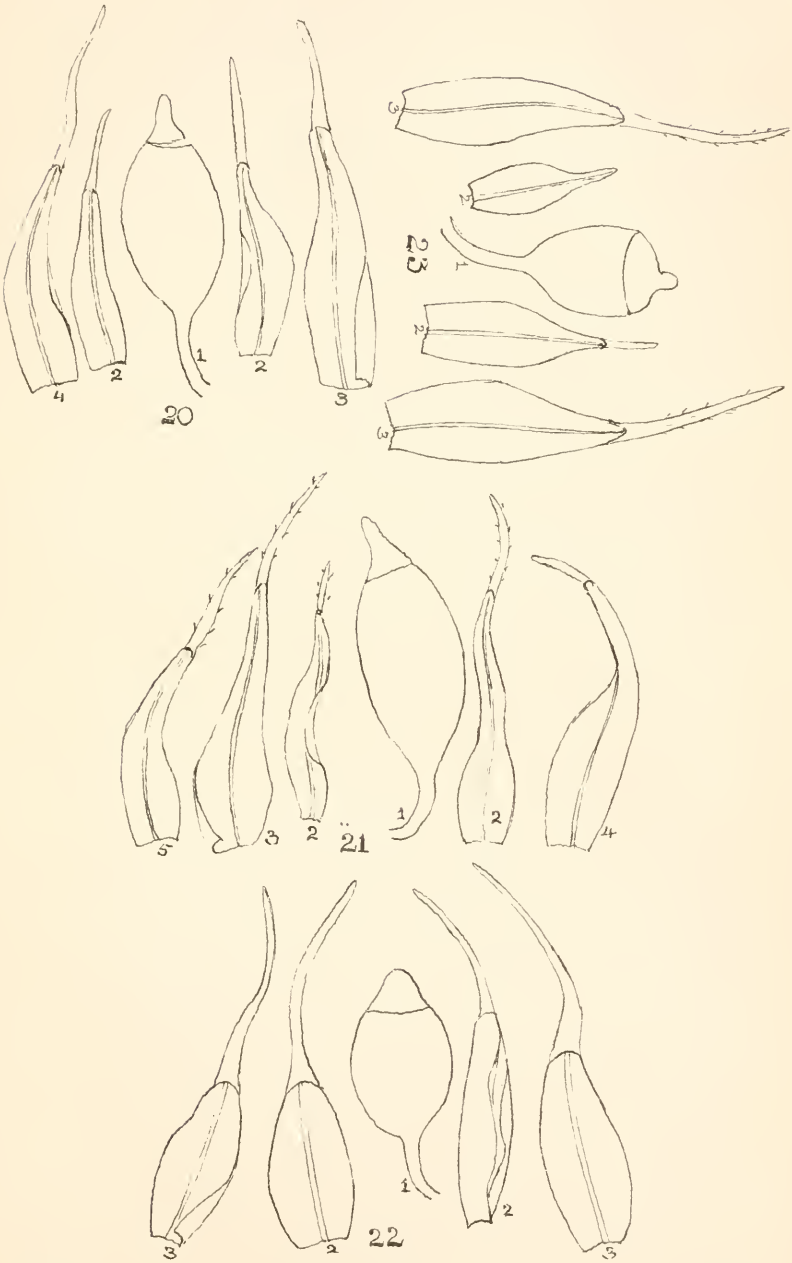
17.

18.



19

RB del[c] GRIMMIA Wde R.B. lith.

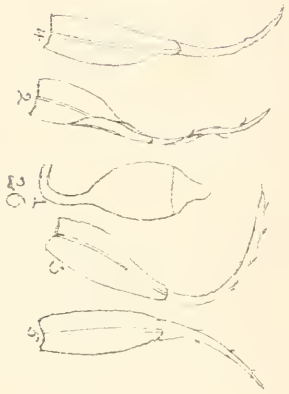


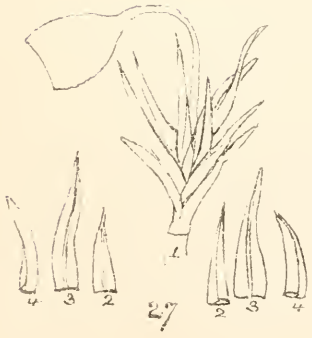
RB del^t

GRIMMIA

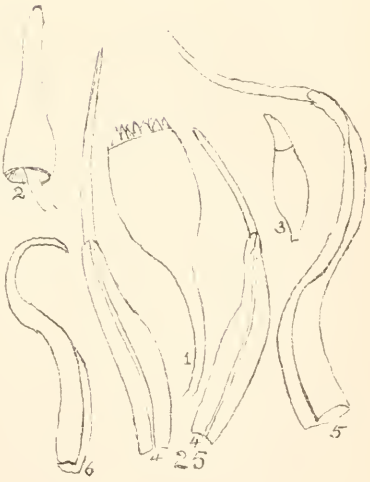
W. de RB lith

24



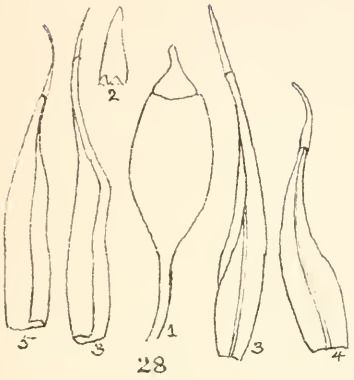


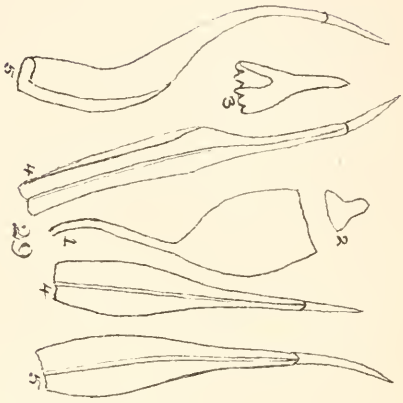
27

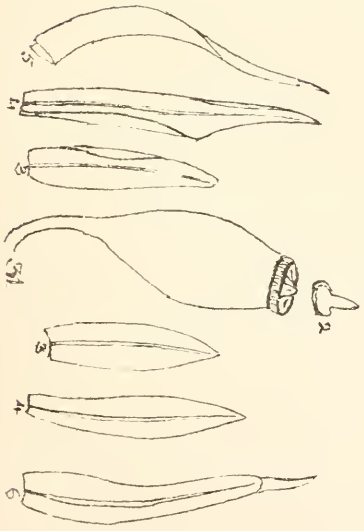


25

R.B. del^t GRIMMIA. W. de R.B. lith



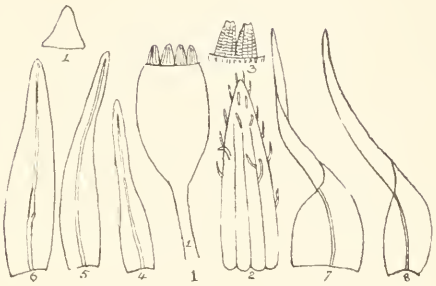


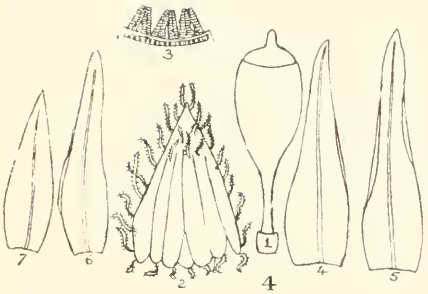


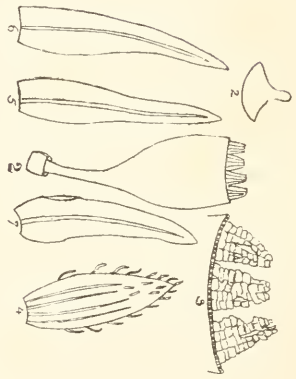
R.B. del.

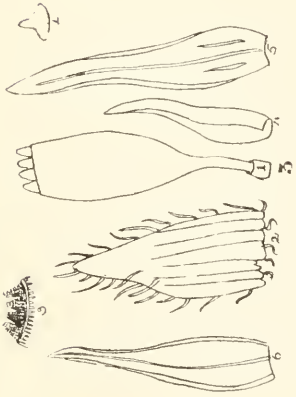
GRIMMIA.

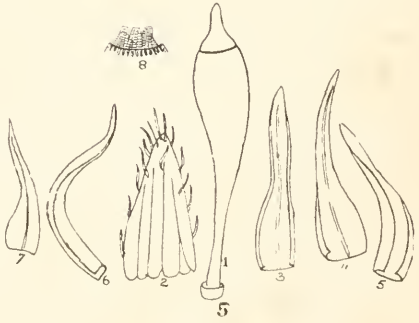
W.deR.B. lith.







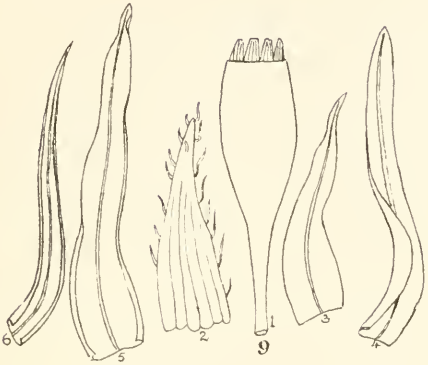


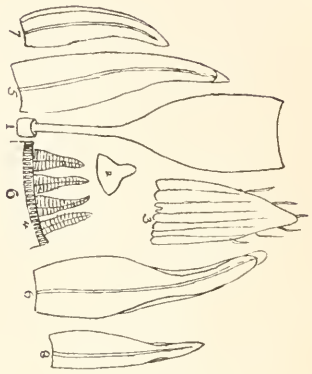


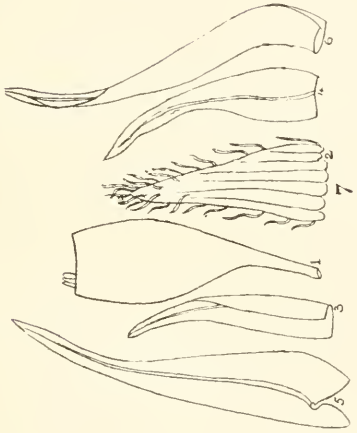
R.B. del

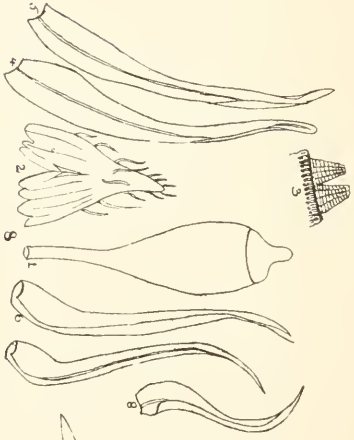
ORTHOTRICHUM

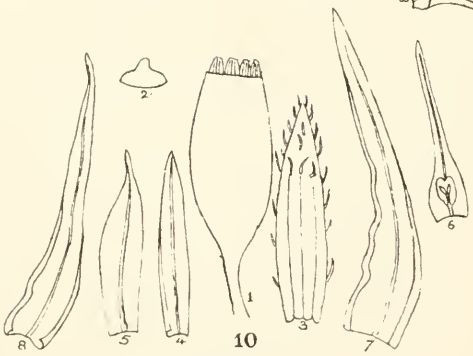
Wde RB lith.







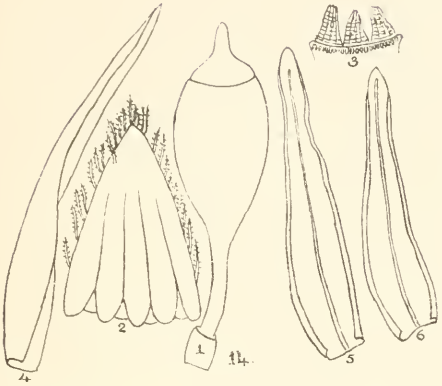


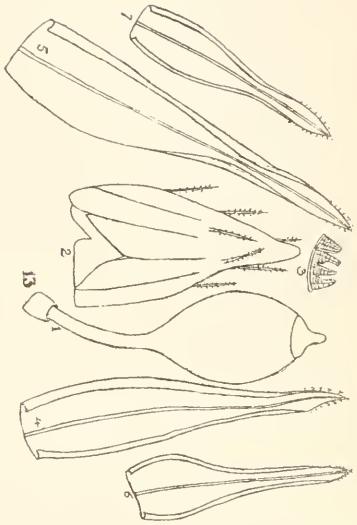


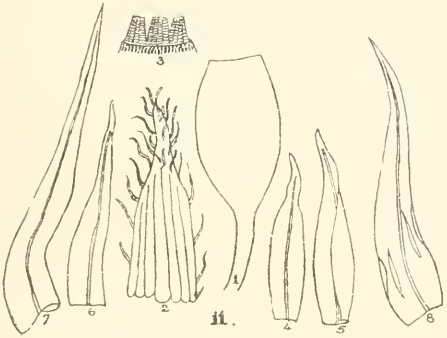
B del

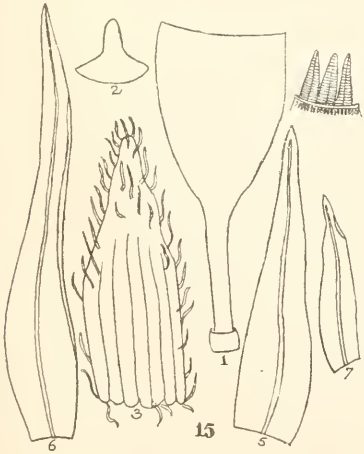
ORTHOTRICHUM.

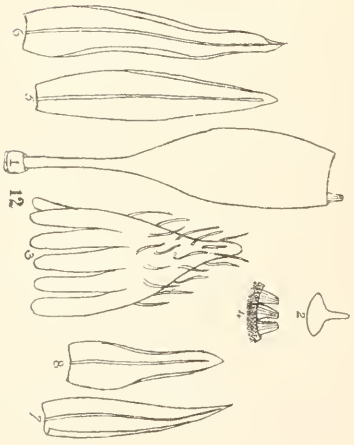
W de RB lith



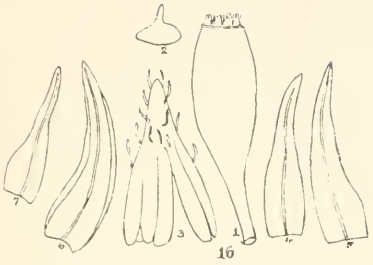


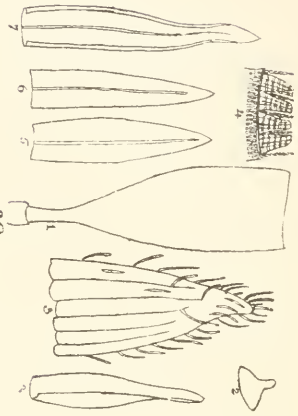


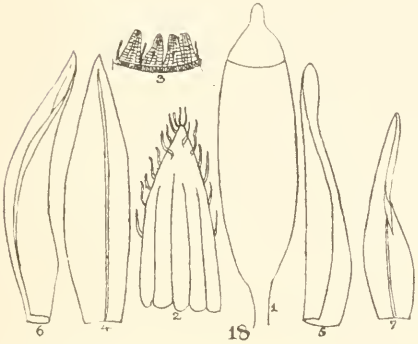


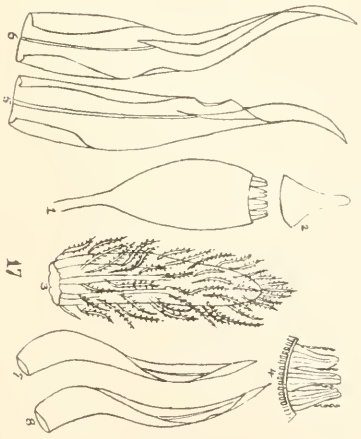


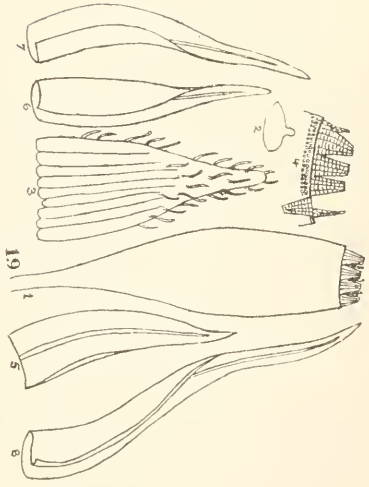
RB. del.t ORTHOTRICHUM W.deRB. lith.







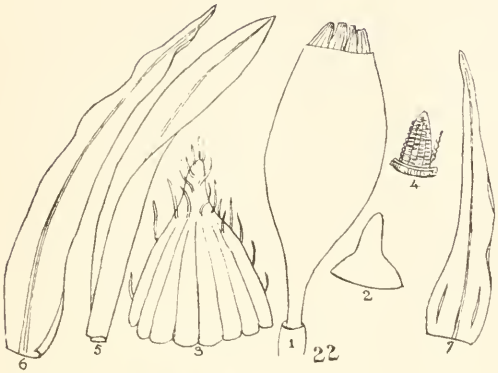


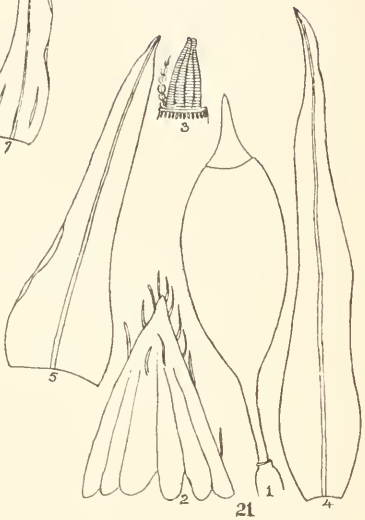


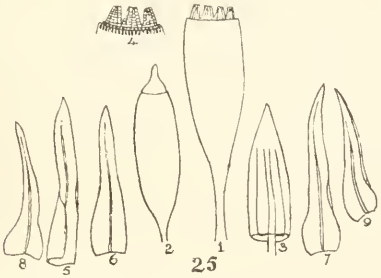
RB del.

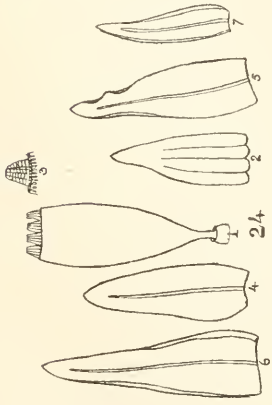
ORTHOTRICHUM

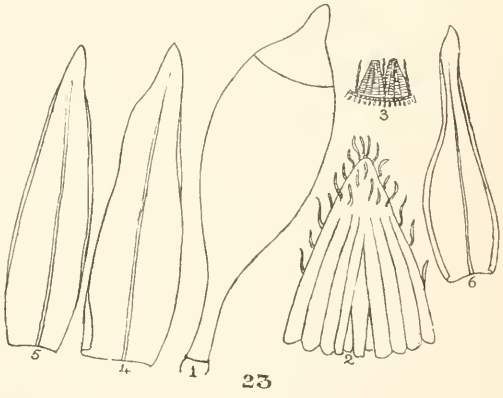
Wde RB. lith.

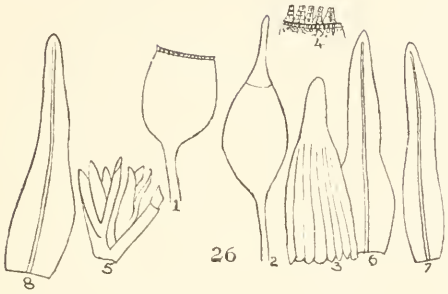

6
5
3
1
2
4
7
22

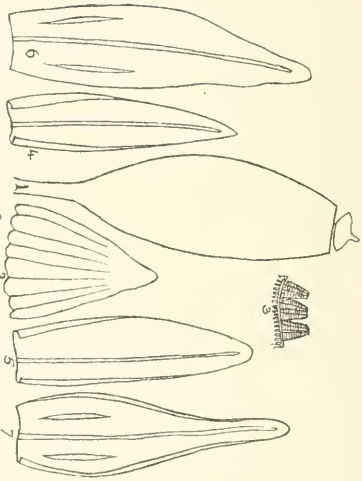

3
5
2
1
4
21

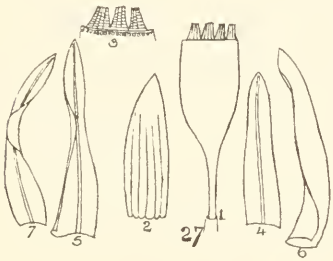

4
8
5
6
2
1
3
7
9
25

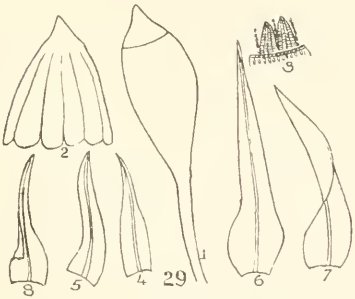

7
5
2
3
1
4
6
24

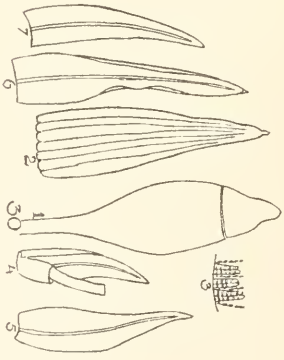

3
6
5
4
1
2
23

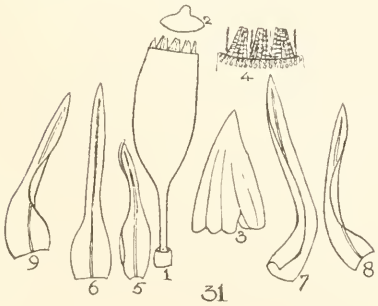

26

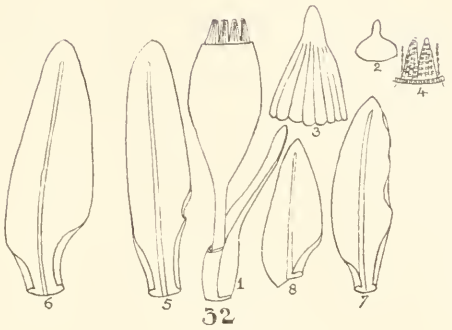

28


27

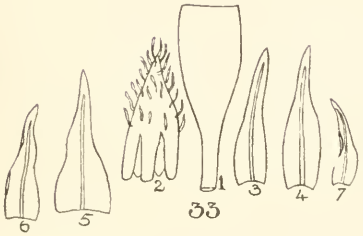

29


30

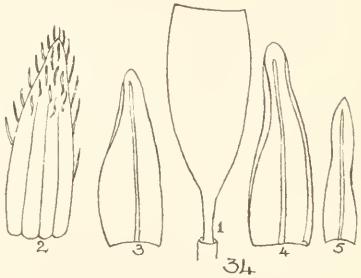

31



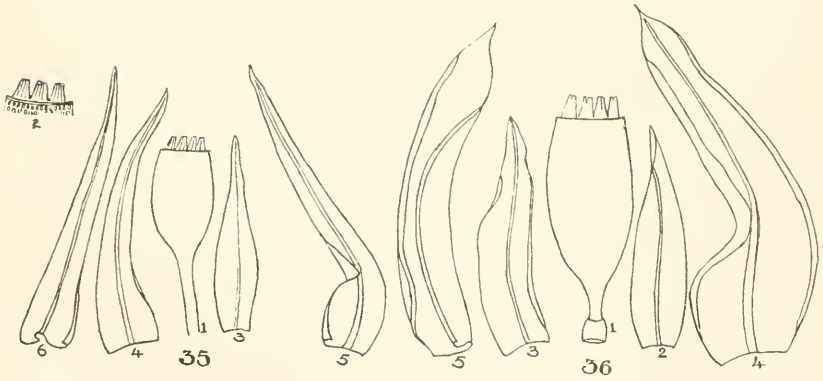
32



33



34

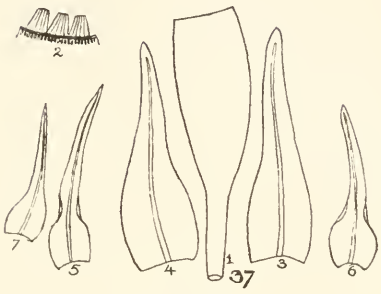


35 36

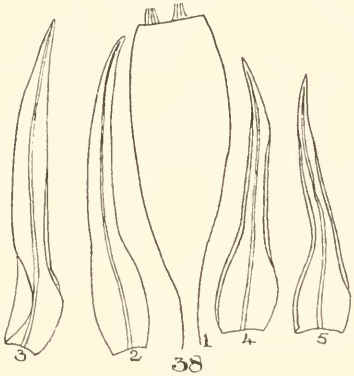
PB del

ORTHOTRICHUM

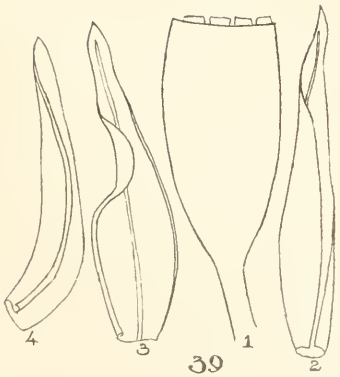
WdeRB lith.



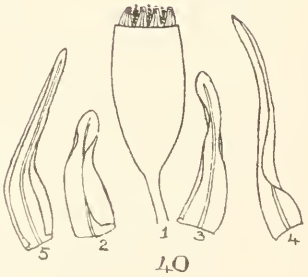
37



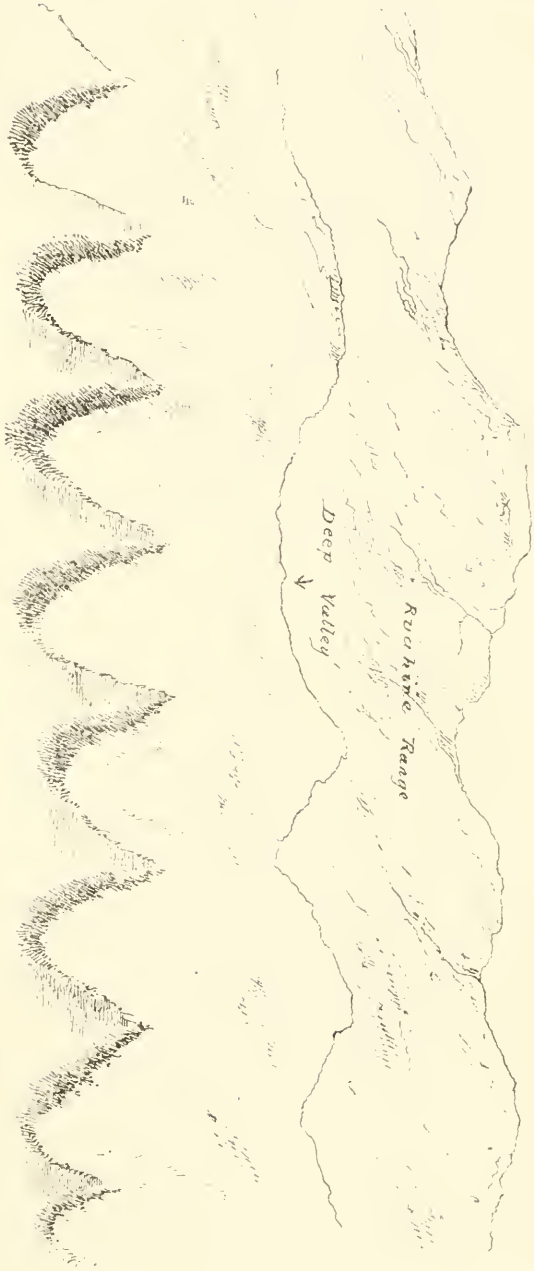
38



39



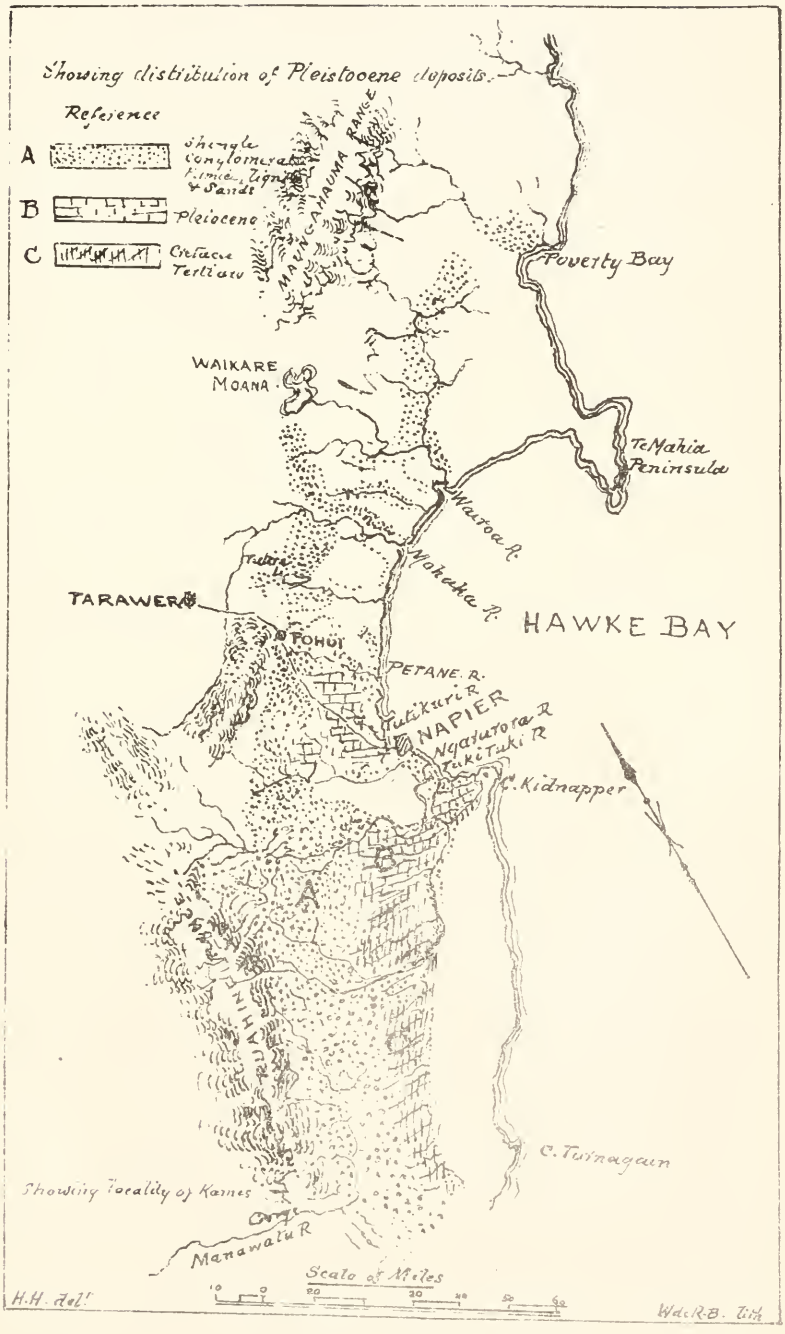
40



Kames on
RUATANIWHA PLAIN, West Side

H.H. del

Wade R.B. Lith.


Showing distribution of Pleistocene deposits.
Reference
A
Shingle
Conglomerate
Pumice, Lignite
& Sands
B
Pleiocene
C
Cretaceous
Tertiary
MAUNGAHAUMA RANGE
Poverty Bay
WAIKARE
MOANA
Te Mahia
Peninsula
Wairoa R.
Mohaka R.
TARAWERA
POHÜI
HAWKE BAY
PETANE R.
Tutikuri R.
NAPIER
Ngaruroro R.
Tukituki R.
C. Kidnapper
A
B
C
C. Turnagain
Showing locality of Kames
Manawatu R.
Scale of Miles
10 0 20 30 40 50 60
H.H. del.
W. de R.B. lith.

DIAGRAMS
Illustrating Inaugural Address
by
MAJ. GEN. SCHAW.

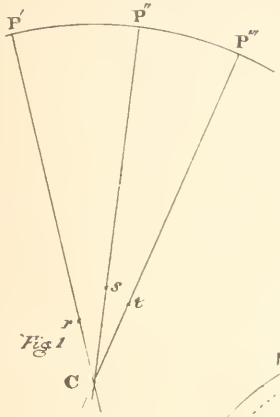


Fig 1

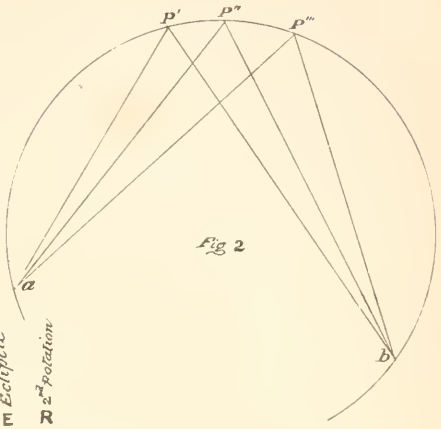


Fig 2

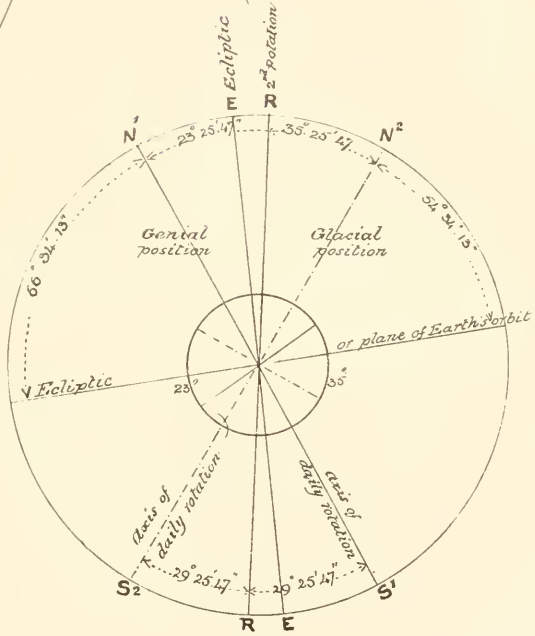


Fig 3

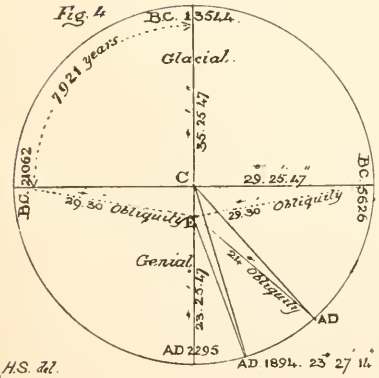


Fig. 4

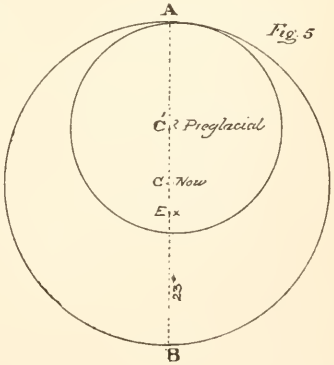
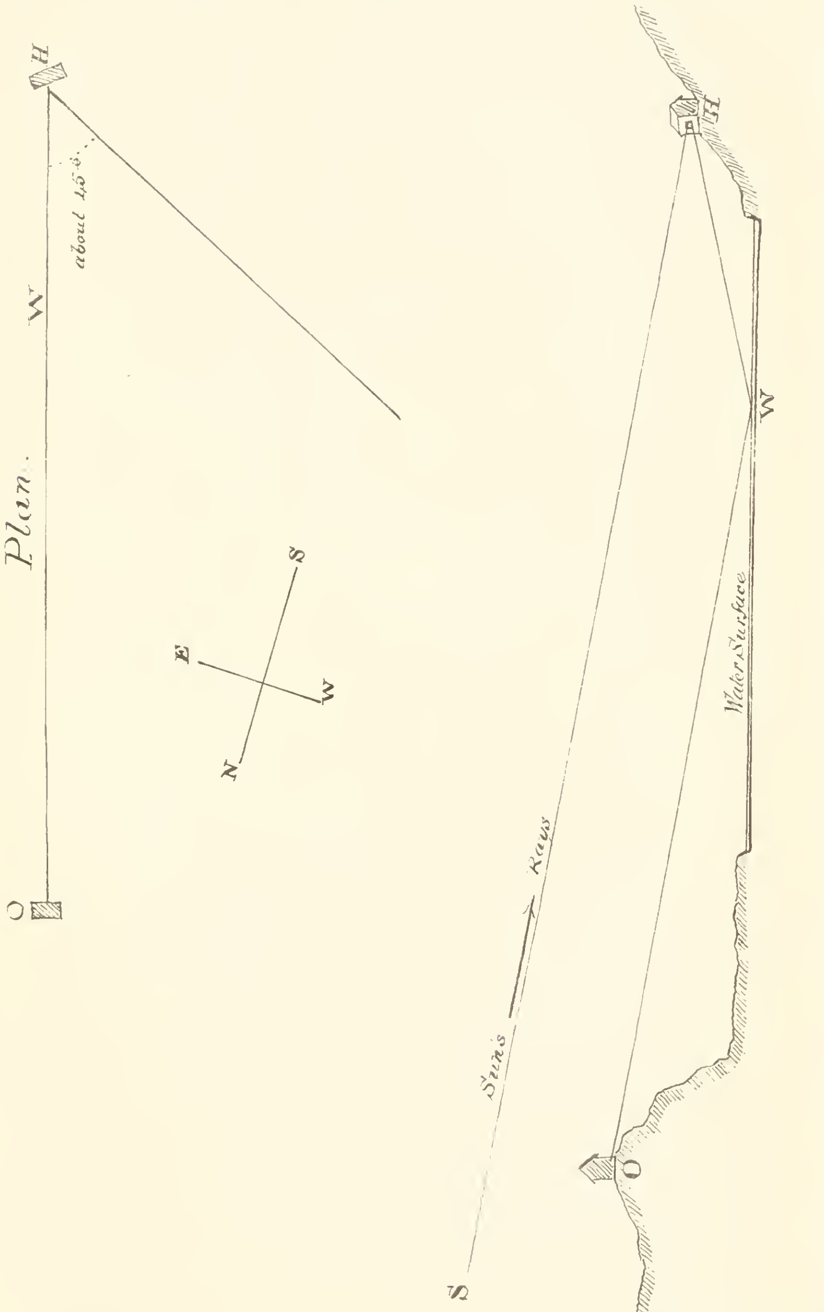


Fig. 5

H.S. del.

Wide R.B. lith.

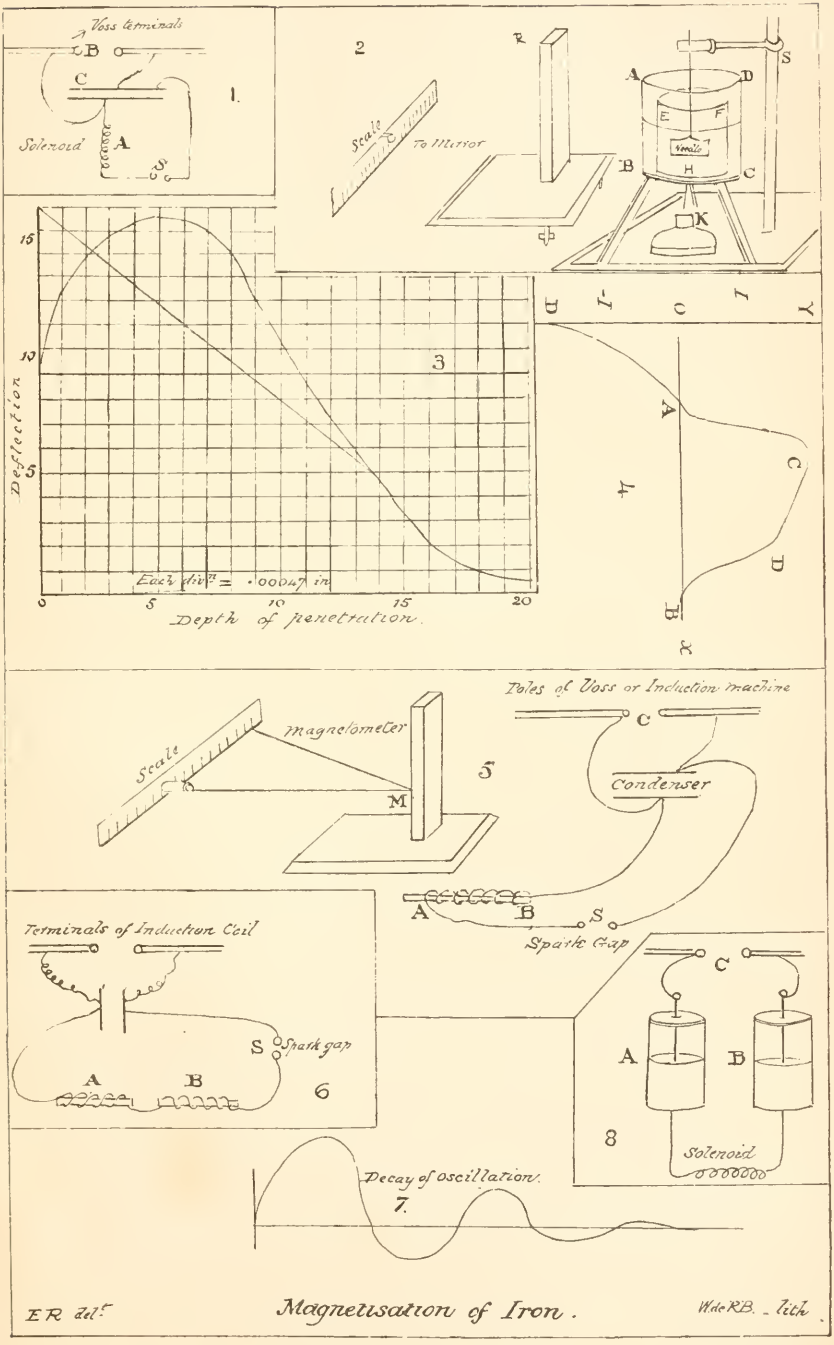


H.S. del. W de R.B. lith.

R. H. del.

Wm. R. B. lith.

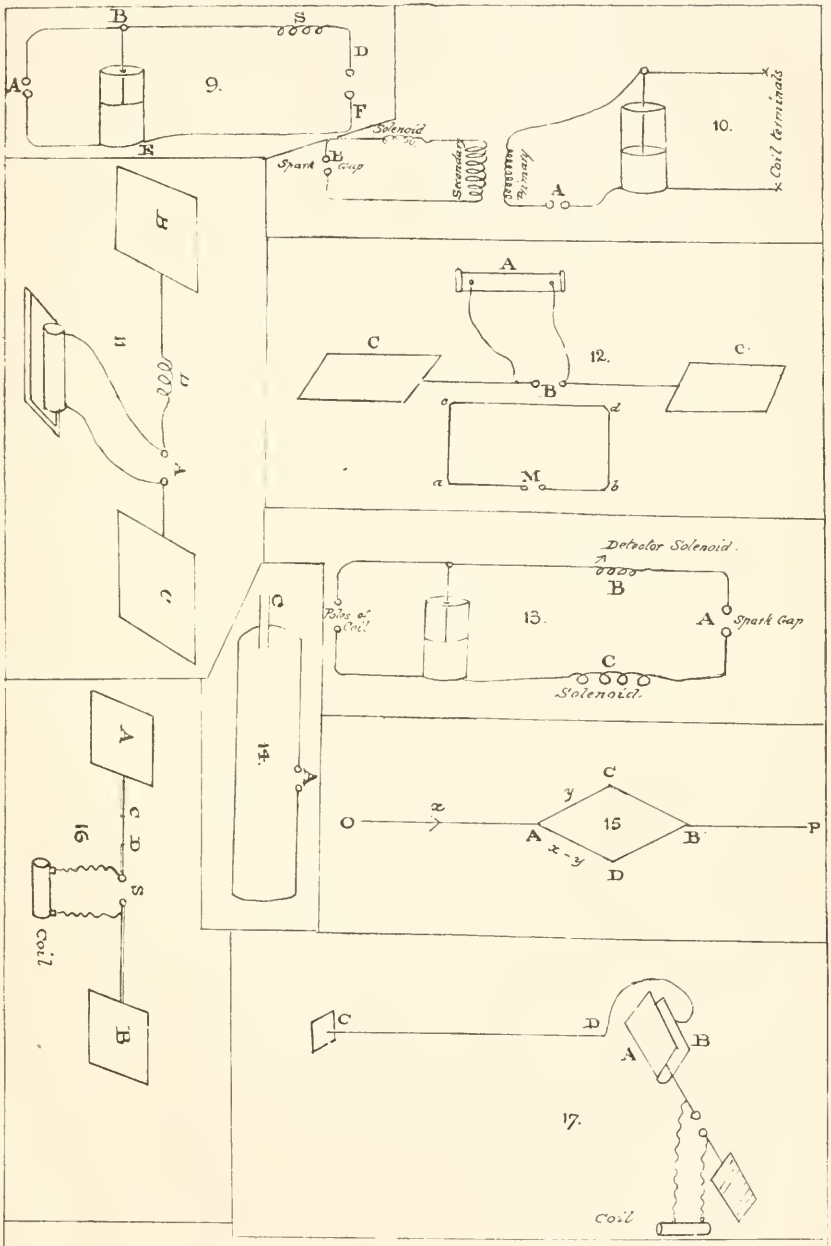
MOA FOOTPRINTS



ER del^t

Magnetisation of Iron.

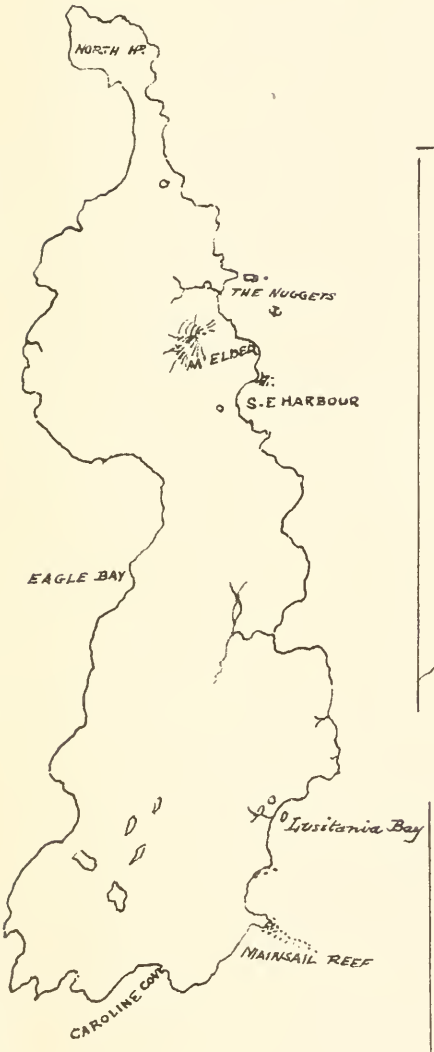
Wide R.B. - lith.

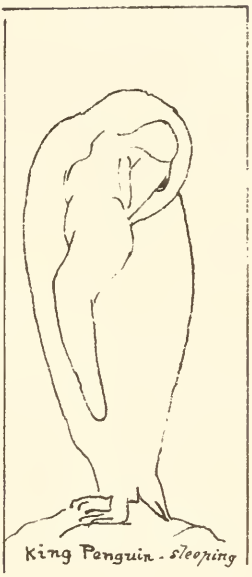


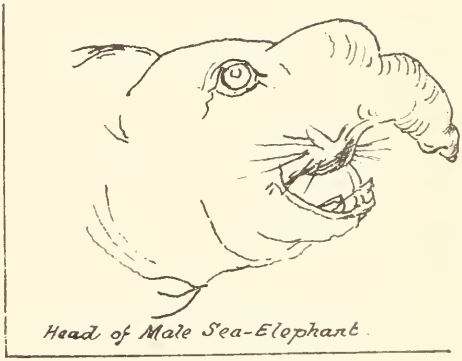
E.R. del.

Magnetisation of Iron.

Wde R.B. lith.




King Penguin - sleeping


Head of Male Sea-Elephant

H. del.t

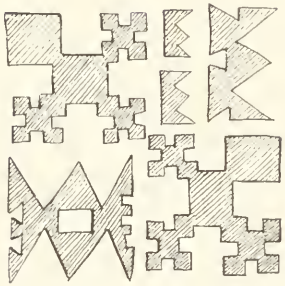
MACQUARIE ISLAND

Wde R.B. lith.

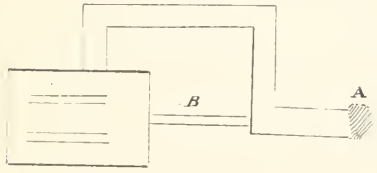
Jar for Ashes and bones

Examples of Pottery

Clay Seal



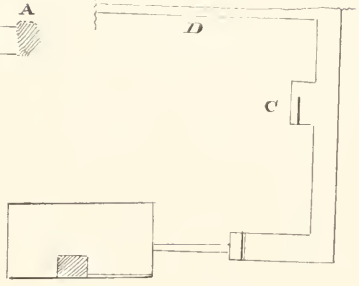
Fac-simile of impression of Seal
½ actual size



Ground plan of Vault

A.. bottom of Shaft

B.. Ventilator or air hole



Horizontal Section

C.... Niche with skeleton of slave or guard

D.... surface trench filled up

PREHISTORIC TOMBS

W. de R. B.

27
1894

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1894

VOL. XXVII.

(TENTH OF NEW SERIES)

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

SIR JAMES HECTOR, K.C.M.G., M.D., F.R.S.

DIRECTOR

ISSUED MAY, 1895

WELLINGTON

SAMUEL COSTALL, GOVERNMENT PRINTING OFFICE

TRÜBNER & CO., 57 & 59, LUDGATE HILL, LONDON, E.C.